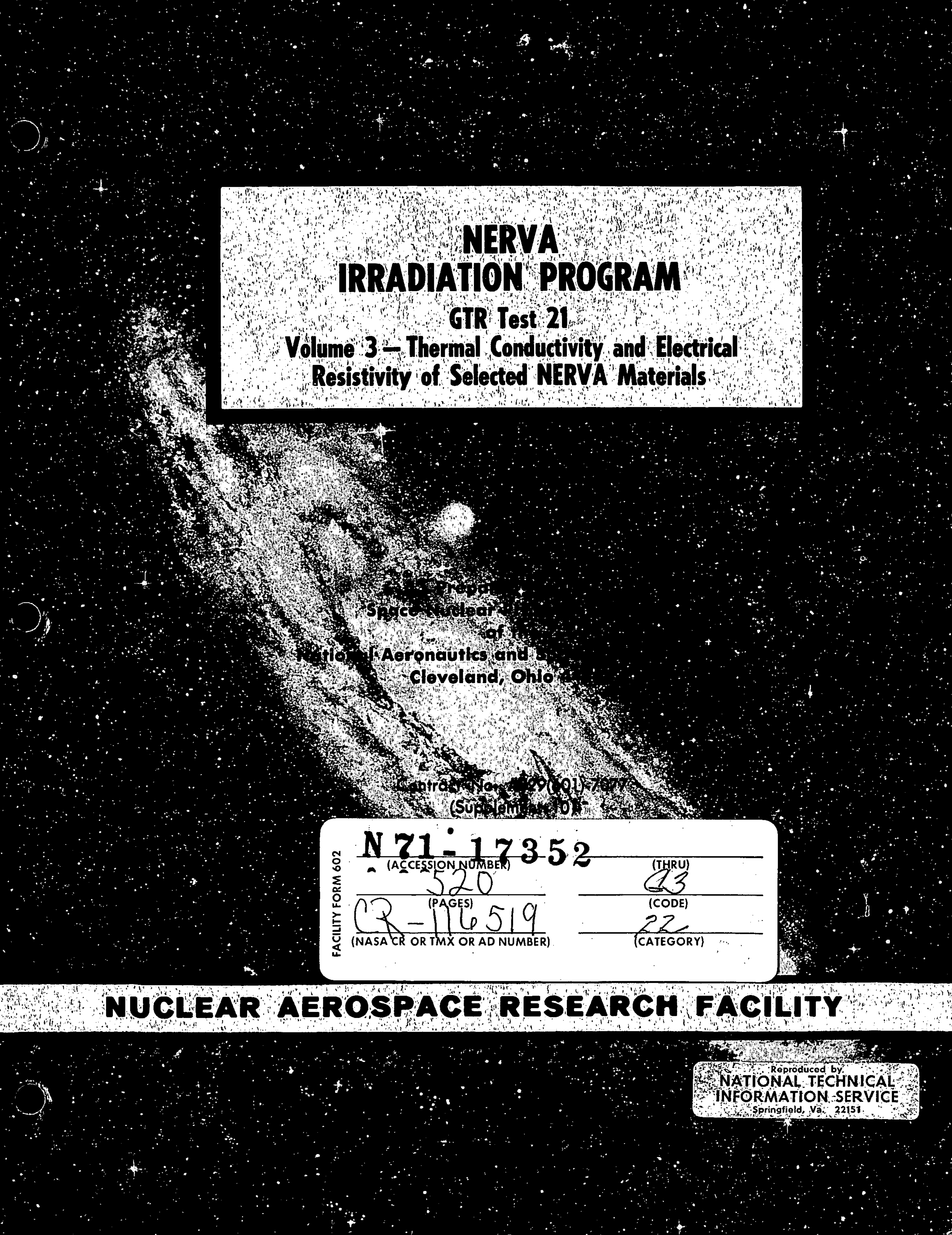

NERVA IRRADIATION PROGRAM

GTR Test 21

Volume 3 — Thermal Conductivity and Electrical Resistivity of Selected NERVA Materials

Prepa...
Space Nuclear ...
of ...
National Aeronautics and S...
Cleveland, Ohio ...

Contract No. ...29(601)-7077
(Supplement 10)

NUCLEAR AEROSPACE RESEARCH FACILITY

FZK 351-3
NJD-20
14 November 1969

NUCLEAR AEROSPACE RESEARCH FACILITY

NERVA IRRADIATION PROGRAM

GTR Test 21

Volume 3 — Thermal Conductivity and Electrical Resistivity of Selected NERVA Materials

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Prepared for the
Space Nuclear Propulsion Office
of the
National Aeronautics and Space Administration
Cleveland, Ohio 44135

Contract No. AF29(601)-7077
(Supplement 10)

GENERAL DYNAMICS
Fort Worth Division

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FOREWORD

GTR Test 21 of the NERVA Irradiation Program was performed at the Nuclear Aerospace Research Facility (NARF) of the General Dynamics Fort Worth Division for the Space Nuclear Propulsion Office, Cleveland, Ohio (SNPO-C) under Statement of Work No. 3 (Attachment G), Contract AF29(601)-7077, Supplemental Agreement No. 10.

The tests described herein were sponsored by Aerojet-General Corporation, Sacramento, California. Their purpose was the study of the effects of nuclear radiation on the thermal conductivity and electrical resistivity of metallic and nonmetallic specimens selected for possible application in the NERVA space engine. The specimens were furnished by the Aerojet-General Corporation, the Westinghouse Astronuclear Laboratory, and the National Bureau of Standards Cryogenic Laboratory at Boulder, Colorado. Part 1 of this document describes the Thermal Conductivity/Electrical Resistivity Test (37/R104) and Part 2 describes the Electrical Resistivity Test (37/R201).

GTR Test 21 also included a para-ortho hydrogen experiment (FZK-351-2), a Beckman hydrogen analyzer experiment (FZK-351-1), and a materials test (FZK-351-4).

ACKNOWLEDGMENTS

The authors wish to express their gratitude to the following persons:

Mr. R. E. Beissner for his work on data analysis and the Wiedemann-Franz Law, and Mr. R. A. Elliott, Mr. M. R. Self, Mr. J. A. Kunselman, and Mr. D. J. La Jaunie and all other General Dynamics personnel who assisted in the accomplishment of the test program.

Mr. D. H. Weitzel, Mr. A. F. Schmidt, Mr. J. G. Hust, and Mr. R. L. Powell of the National Bureau of Standards, Boulder, Colorado, for their design recommendations and constructive criticism, which were of particular significance in the successful accomplishment of the thermal conductivity test.

Mr. R. H. Sanders and other Aerojet-General Corporation personnel for their attentive response to problems encountered and their overall assistance in the accomplishment of the experimental plan.

SUMMARY

The Nuclear Aerospace Research Facility of General Dynamics Fort Worth Division performed two tests for Aerojet-General Corporation in accordance with the test specifications in AGC Report No. RN-S-0411. These tests were:

- Test 37/R104, Thermal Conductivity/Electrical Resistivity
- Test 37/R201, Electrical Resistivity

The purpose of the test 37/R104 was to investigate the effects of nuclear radiation on the thermal conductivity of the following selected NERVA materials:

Ti-5 Al-2.5 Sn-ELI
Graphite PO-3
Al 7039-T61
WANL Beryllium
NBS Beryllium

The objectives were:

1. To determine if a change in thermal conductivity occurred.
2. To measure the thermal conductivity over a selected temperature range.
3. To determine if the Wiedemann-Franz Law is applicable in predicting thermal conductivity by use of the measured electrical resistivity.

These specimens were irradiated in a liquid nitrogen environment to neutron fluences ranging from 5×10^{17} n/cm^2 to 1.3×10^{18} n/cm^2 ($E > 1$ MeV). The thermal conductivity and electrical

resistivity of each specimen was determined before and after irradiation, and after a postirradiation-anneal at ambient temperature. Data were obtained at temperatures ranging from $80^{\circ}K$ to $390^{\circ}K$, dependeing upon the specimen type. The results of this test were:

1. A change in thermal conductivity occurred in all specimens except the titanium.

2. The Wiedemann-Franz Law using the ideal Lorenz number does not predict the thermal conductivity of most metals to the accuracy that can be obtained using a predetermined preirradiation Lorenz number and is not applicable for those metals where the thermal conductivity is dominated by the lattice components.

The purpose of the test 37/R201 was to investigate the applicability of the Wiedemann-Franz Law for predicting the effects of nuclear radiation on the thermal conductivity of the following selected NERVA materials:

Graphite PO-3
Beryllium
Al 7039-T61 (2 specimens)
Ti-5 Al-2.5 Sn-ELI
Inconel 718
A-286
Hastelloy X
SS-347

The objectives of this test were:

1. To measure electrical resistivity over a selected temperature range.

2. To determine if the Wiedemann-Franz Law is applicable in predicting the effects of nuclear radiation on thermal conductivity of materials.

3. To determine the temperature of anneal at which the electrical resistivity of the irradiated specimens recovered to their preirradiation values.

Electrical resistivity data were measured before irradiation from $80^{\circ}K$ to $300^{\circ}K$, during irradiation at LN_2 temperature, and after irradiation from $80^{\circ}K$ to $460^{\circ}K$. These specimens were irradiated at LN_2 temperature to a neutron fluence of 3.3×10^{17} n/cm^2 ($E > 1$ MeV). Data at LN_2 temperature were obtained on all specimens in between each temperature step from $80^{\circ}K$ to $460^{\circ}K$. The results of this test were:

1. A change in electrical resistivity ($> 1\%$) occurred in the titanium, graphite, beryllium, and aluminum specimens.

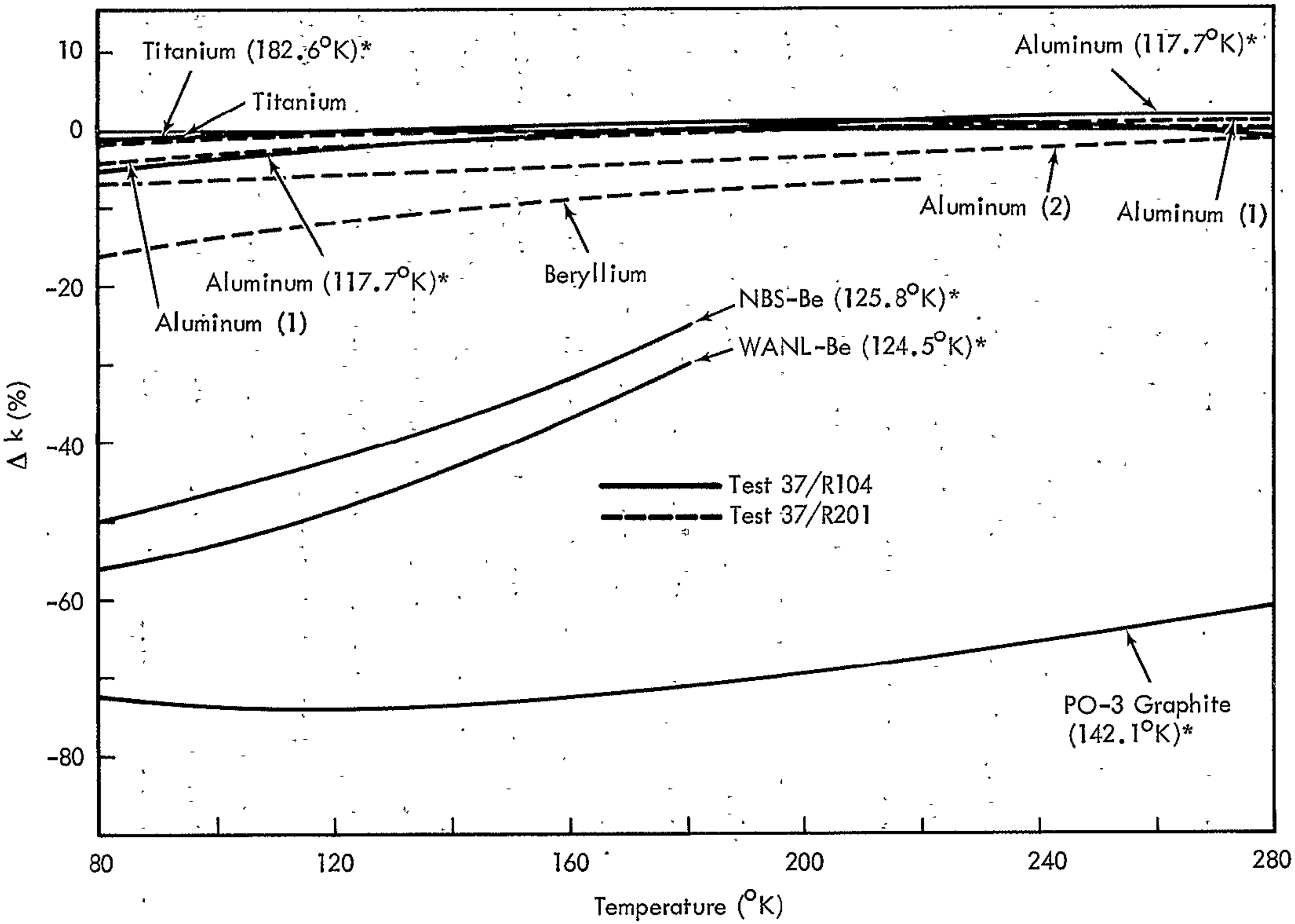
2. The Wiedemann-Franz Law is not applicable using the Sommerfeld Value of the Lorenz number.

3. After annealing, complete recovery was experienced in all specimens except graphite.

Figure S-1 is a summary of the percent change in the thermal conductivity (Δk) from preirradiation to postirradiation as a function of temperature for each of the materials tested in both experiments. The materials not shown experienced a change of less than 1%. The Δk for the R201 materials were calculated using the Wiedemann-Franz Law and the Sommerfeld Value (2.44×10^{-8} watt-ohm/$^{\circ}K^2$) of the Lorenz number and do not necessarily represent a true picture of the change in thermal conductivity for those specimens. Thermal conductivity for the graphite specimen (37/R201) was not calculated because the Wiedemann-Franz

Law does not apply for this material. After annealing, all specimens regained their original thermal conductivity values except the graphite specimens in each of the two experiments. The 37/R104 specimens were irradiated at temperatures above 77.4^{o}K, as noted in Figure S-1, because they were not in direct contact with the liquid nitrogen.

Figure S-2 is a summary of the percent change in electrical resistivity ($\Delta\rho$) from preirradiation to postirradiation as a function of temperature for each of the materials tested in both experiments. Again, only the materials with a change greater than 1% are plotted.



*Maximum Temperature of Specimen During Irradiation

Figure S-1 Percent Change in Thermal Conductivity for All Materials as a Function of Temperature

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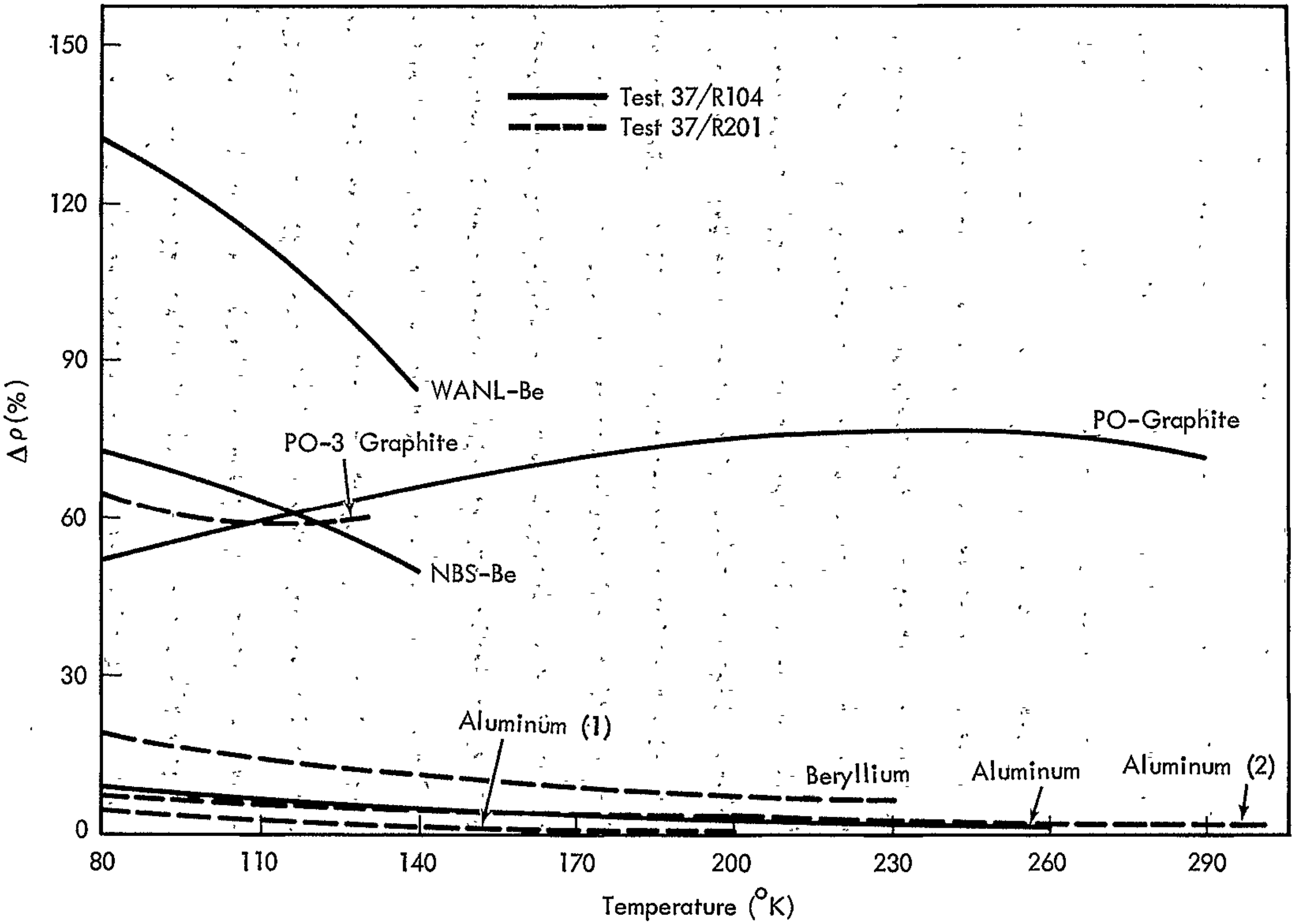

Figure S-2 Percent Change in Electrical Resistivity for All Materials as a Function of Temperature

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I. INTRODUCTION

The Nuclear Aerospace Research Facility (NARF) at the Fort Worth Division of General Dynamics is conducting a series of tests to determine the effects of nuclear radiation, in combination with other environmental factors, on materials proposed for application in the NERVA engine. Aerojet-General Corporation (AGC) has prime responsibility for development of the NERVA engine; the nuclear reactor in the engine is being developed by Westinghouse Electric Corporation.

This document reports the procedures and results of tests performed on materials during the irradiation designated GTR Test 21. The purpose of the tests discussed in this document was to determine the effects of radiation on the thermal conductivity and electrical resistivity of several NERVA materials.

The tests were performed in accordance with specifications submitted by AGC. The test specimens were supplied by Aerojet-General, Westinghouse Astronuclear Laboratory (WANL), and the National Bureau of Standards (NBS), Boulder, Colorado.

The Thermal Conductivity/Electrical Resistivity Test (37/R104) is reported in Part 1 (Sections II and III) of this document. In this test five specimens of four different materials were irradiated in a liquid nitrogen environment to neutron fluences ranging from 5×10^{17} n/cm^2 to 1.3×10^{18} n/cm^2

(E > 1 MeV).

The Electrical Resistivity Test (37/R201) is reported in Part 2 (Sections IV and V). Ten specimens of eight different materials were irradiated in liquid nitrogen to a neutron fluence of 3.3×10^{17} n/cm^2 (E > 1 MeV).

These tests were performed using the Ground Test Reactor (GTR) facility described in Appendix A. The reactor was operated for a total of 2310 MWh at different power levels ranging from 0.72 to 7.2 MW.

The dosimetry techniques and data are presented in Appendix B. The radiation history of the test is presented in Appendix C. Supplementary data on thermocouple calibration and on the specimens are presented in Appendices D, E, F, and G.

Part 1

THERMAL CONDUCTIVITY/ELECTRICAL RESISTIVITY

Test 37/R104

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II. TEST PROGRAM FOR THERMAL CONDUCTIVITY/ELECTRICAL RESISTIVITY TEST 27/R104

The purpose of the Thermal Conductivity/Electrical Resistivity Test was to investigate the effects of nuclear radiation on the thermal conductivity of selected NERVA materials. Specific objectives were:

1. To measure the thermal conductivity at temperatures between 77° and 300°K
2. To determine the change in thermal conductivity due to irradiation (by comparison of data taken prior to and following the irradiation)
3. To determine the applicability of the Wiedemann-Franz law to the prediction of thermal conductivity from the measured electrical resistivity

2.1 Material Specimens

Five specimens were irradiated and tested: one of a 7039-T61; two of beryllium, one supplied by NBS and the other by WANL; one of titanium (Ti-5 Al-2.5 Sn ELI); and one of graphite PO-3. The material properties of the specimens are given below; the compositions of the materials were provided by AGC, WANL, or NBS as noted.

2.1.1 Aluminum 7039-T61

The aluminum specimen was fabricated from a plate, 0.75 by 6.0 by 12 in. (Lot 086681), supplied by the Kaiser Department of Metallurgical Research. The specimen diameter was 0.442 cm and its cross-sectional area 0.153 cm^2.

Composition (wt %) of Aluminum Specimen (Data provided by AGC)		
Element	Kaiser Analysis	AGC Analysis*
Al	92.5	93.1
Zn	3.86	3.75
Mg	2.86	2.45
Mn	0.25	0.23
Cr	0.21	0.20
Fe	0.17	0.16
Sn	0.07	0.07
Cu	0.03	0.06
Ni	0.01	0.02

*Spectrographic

2.1.2 NBS Beryllium

The NBS beryllium specimen was furnished to NBS by Paul Wagner of the Los Alamos Scientific Laboratory. The specimen's axis was perpendicular to the pressing axis. The diameter was 0.368 cm and the cross-sectional area 0.106 cm^2.

Composition (wt %) of NBS Beryllium
(Data provided by NBS)

Be	96.53	Mn	0.054
BeO	3.20	B	< 1 ppm
Al	0.13	Li	< 1 ppm
Ni	0.089		

2.1.3 WANL Beryllium

The WANL beryllium specimen (WANL PDS-30018) was machined from Brush Beryllium S-200 grade vacuum hot-pressed block. The

axis of the specimen was in the transverse direction (perpendicular to the pressing direction). The specimen density was 1.86 g/cm^3 and the grain size was estimated to be ASTM No. 7. The test specimen had a diameter of 0.442 cm and a cross-sectional area of 0.153 cm^2.

Composition (wt %) of WANL Beryllium
(Data provided by WANL)

Be	98.4	Si	0.04
BeO	1.7	Ti	0.024
Fe	0.14	Ni	0.022
C	0.13	Mn	0.015
Cr	0.12	Cu	0.011
Al	0.06	Mg	0.01

2.1.4 <u>Titanium (Ti-5 Al-2.5 Sn ELI)</u>

The titanium specimen (WANL PDS-30029-B) was machined from hot-rolled annealed and centerless-ground bar 1.0 in. in diameter purchased by WANL from Reactive Metals, Inc. It was ultrasonically tested prior to preparation of the test specimen, which was 1.588 cm in diameter with a cross-sectional area of 1.978 cm^2.

Composition (wt %) of Titanium
(Data provided by WANL)

Ti	91.8	C	0.02
Al	5.4	N	0.005
Sn	2.5	B	0.005
Fe	0.18	H	49 ppm
O	0.07		

2.1.5 PO-3 Graphite

The PO-3 graphite thermal conductivity specimen (WANL PDS-30086) was prepared from an isostatically pressed log 7 in. in diameter by 72 in. long purchased by WANL from the Pure Carbon Co. In the isostatic molding process, carefully sized coke particles (~3 mils in diameter) and an appropriate binder are packed into a rubber mold and then hydrostatically pressed under a fluid in a pressure vessel. The resulting compact is cured, carbonized, and graphitized.

Specimens were taken in the axial direction (along the axis of the log). The measured density was 1.75 g/cm^3 (avg) and the electrical resistivity was 1.55 $\mu\Omega$-cm. The test specimen had a diameter of 1.077 cm and a cross-sectional area of 0.910 cm^2.

2.2 Specimen Test Units

The thermal conductivity of each material was determined by measuring the axial heat flow through a small-diameter cylindrical specimen. The design of the test unit, shown in Figure 2-1, closely resembles that employed by NBS in their thermal conductivity program. The thermal conductivity test units and the associated experimental hardware were designed and manufactured at NARF. Technical and design recommendations were provided by both NBS and AGC.

As indicated in Figure 2-1, each test specimen was enclosed in a steel container (outer can assembly) that could be evacuated

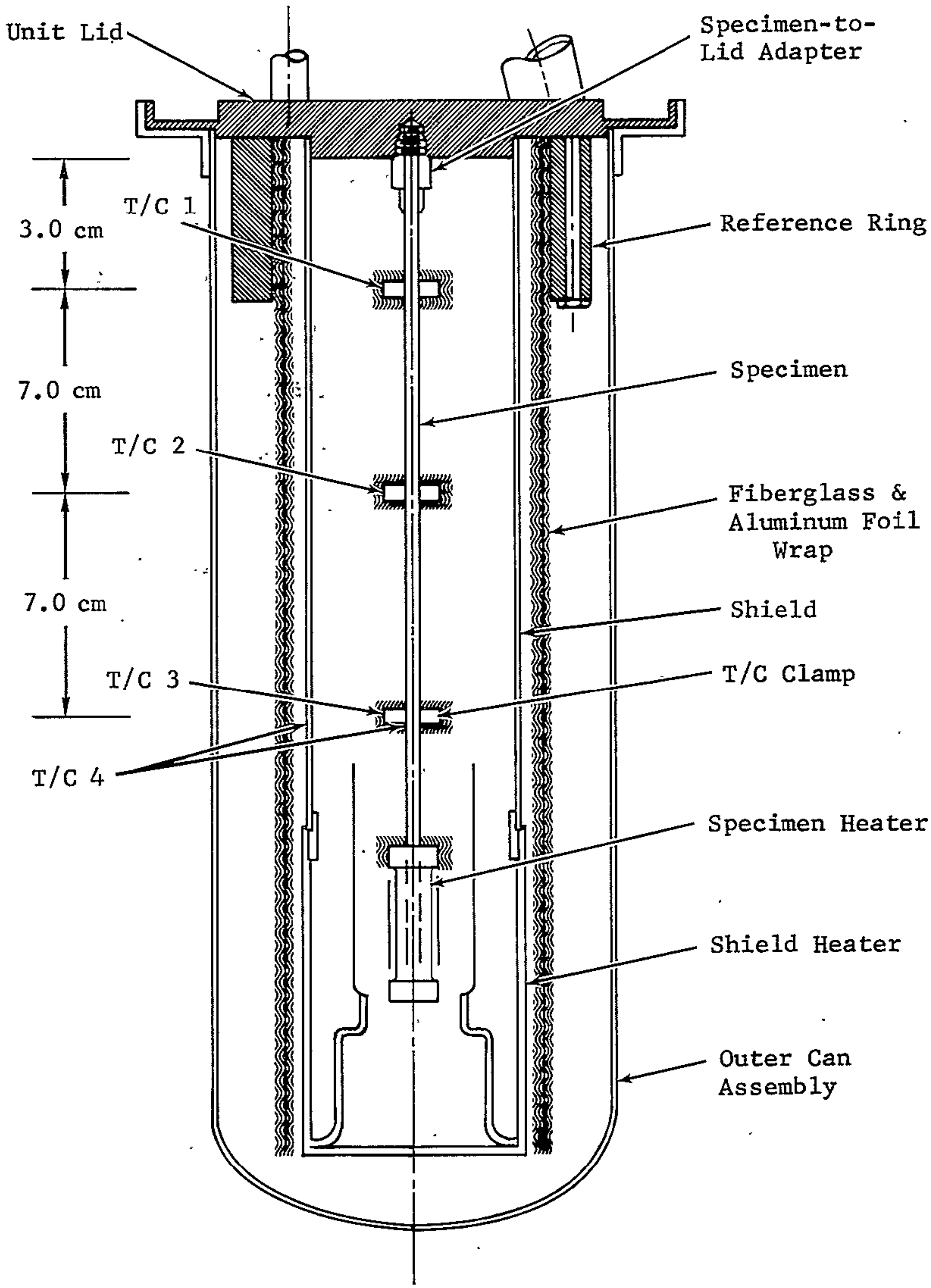

Figure 2-1 Simplified Drawing of Thermal Conductivity Apparatus (test unit)

or filled with an inert gas as required. The upper end of the specimen was attached to the copper lid of the unit; the lid served as a heat sink when the unit was submerged in a cryogen reference bath. The lower end of the specimen was attached to a heater that supplied a known amount of heat to the specimen. Heat losses from the specimen were minimized by surrounding the specimen with a heat shield and by evacuating the test unit to below 10^{-4} mm-Hg. The heat shield was made of the same material as the specimen so as to have approximately the same temperature distribution. However, it should be noted that because of the fragility of the graphite, it was necessary to provide a composite shield for the graphite unit; this shield consisted of graphite with a steel backing separated from the graphite by mica.

The temperature of each specimen was monitored by means of three Chromel/constantan thermocouples (T/C 1, T/C 2, and T/C 3) located on the specimen as shown in Figure 2-1. A differential thermocouple (T/C 4) was located between the specimen and its heat shield in approximately the same plane as T/C 3. All thermocouples were referenced to the cryogen bath, so that the measured temperatures represented the difference between the heat-sink temperature and the temperature at the point of measurement on the specimen.

In addition to the thermocouples mounted inside the unit, one ungrounded thermocouple (T/C 5) was mounted on top of the unit lid, one grounded thermocouple was embedded in the lid on the centerline of the specimen (Sample T/C), and one grounded thermocouple was embedded in the lid on the centerline of the reference-ring rim (Ring T/C). These thermocouples were referenced to a solid copper block in the cryogen bath and were used to determine the temperature difference between the heat sink and the cryogen reference bath.

All thermocouples were made from Omega 5-mil Chromel and constantan wires insulated with unimpregnated fiberglass. Prior to instrumenting the specimen test units, several thermocouples were made from wire taken from different places in the spools. These thermocouples were calibrated and thermocouple emf-vs-temperature tables were generated using standard procedures. The calibration procedure is presented in Appendix D.

Figure 2-2 shows two beryllium specimens, the specimen and shield heaters, the thermocouple clamps, and the specimen-to-lid adapters. All thermocouple clamps were made of copper, with the exception of those used on the graphite specimen. Invar thermocouple clamps, supplied by AGC, were used with the graphite specimen to ensure optimum thermal contact between the clamp and the specimen over the temperature range of this experiment.

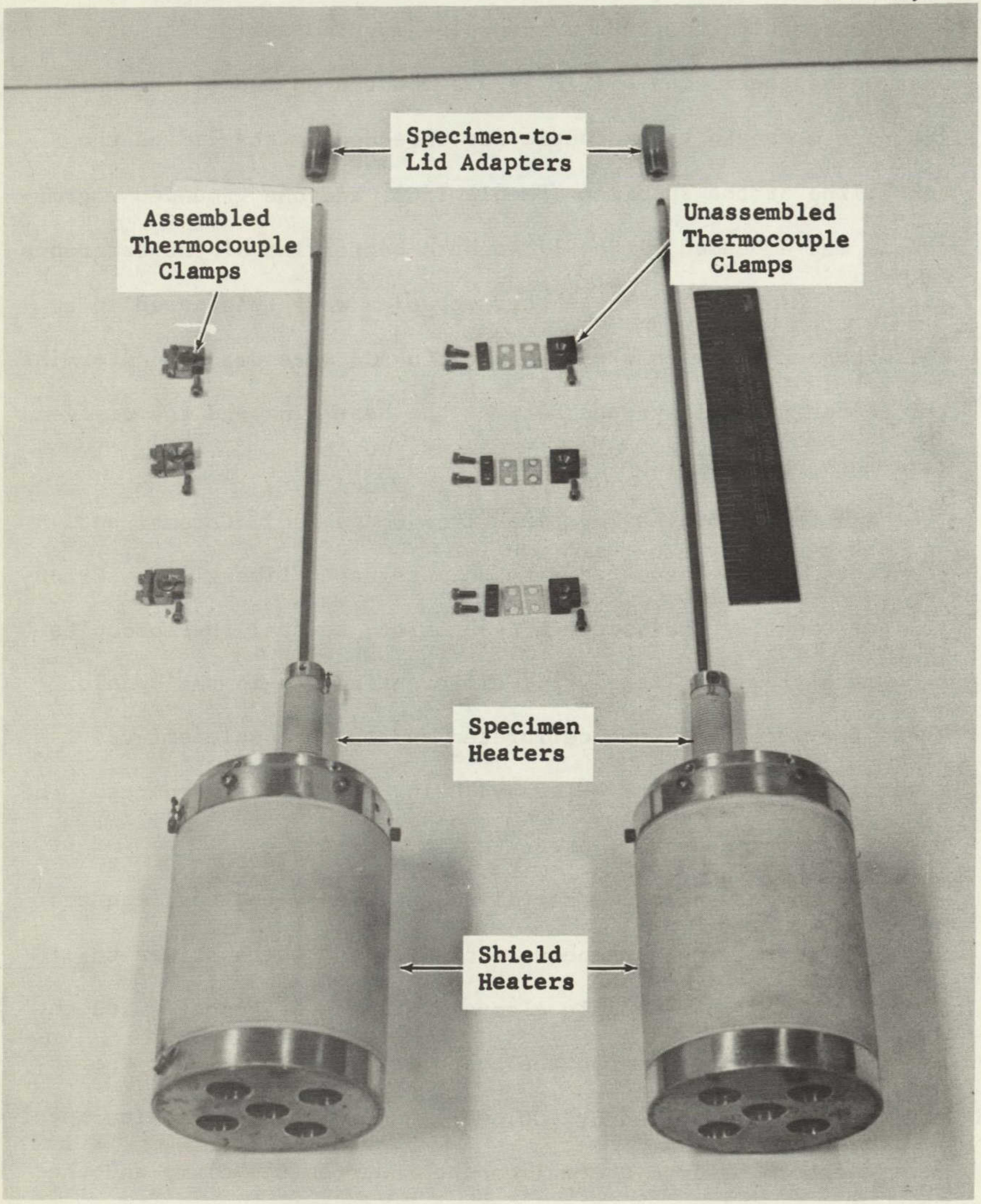

Figure 2-2 Internal Piece Parts of Thermal Conductivity Test Apparatus (Beryllium)

The specimen shield was clamped to the copper heat sink (unit lid) at the upper end and to a shield heater at the lower end. During the experiment, the specimen and its shield were brought to the same temperature at the location of T/C 3. This was accomplished by adjusting the shield-heater power until the differential thermocouple T/C 4 between the shield and the specimen indicated zero emf. It was then assumed that the temperature distributions along shield and specimen were approximately the same.

Each of the thermocouple leads to the specimen penetrated the shield and was thermally tempered to the outer surface of the shield in the plane of the thermocouple junction. The tempered lengths were held in place with Rokide insulation. Tempering in this case refers to the attachment, thermally, of the thermocouple lead wires to the shield at a location where the temperature of the shield approaches that of the thermocouple junction. The lead wires were in thermal contact but electrically isolated from the tempering surface. Tempering was desired in order to reduce heat transfer from the thermocouple junction, thereby reducing thermocouple sensing error and conduction losses from the specimen.

The specimen heater and shield heaters were designed and manufactured by AGC. All heater mandrels were made of aluminum except the one for the graphite specimen; it was made of graphite.

The mandrels were first covered with a layer of Rokide; then several turns of either 5-mil or 10-mil constantan wire were wound around the mandrel over the initial Rokide coating to form the heater element. A final coating of Rokide was applied over the element to hold it in place.

Different methods of attaching the specimens to the heat sink were employed, depending upon the specimen material and configuration. The specimens were of different diameters to ensure optimum conditions for the measurement of thermal conductivity; some were threaded, others were not. It was therefore necessary to employ different methods of clamping the specimens to the heat sink. These were of two basic types - the specimen was either threaded onto the specimen and the adapter was in turn threaded into the sink or the specimen was threaded directly into the heat sink. In both basic types of attachment, indium was used to enhance thermal contact between the specimen and the heat sink for all materials except graphite, for which a gallium-indium mixture was used.

The specimens were attached to the specimen heaters either by threading the specimen into the heater or by pressing the specimen into the heater. In both cases thermal contact was enhanced through the use of indium.

Figure 2-3 shows one half of a representative specimen shield with the thermocouple leads tempered to the shield back. Each

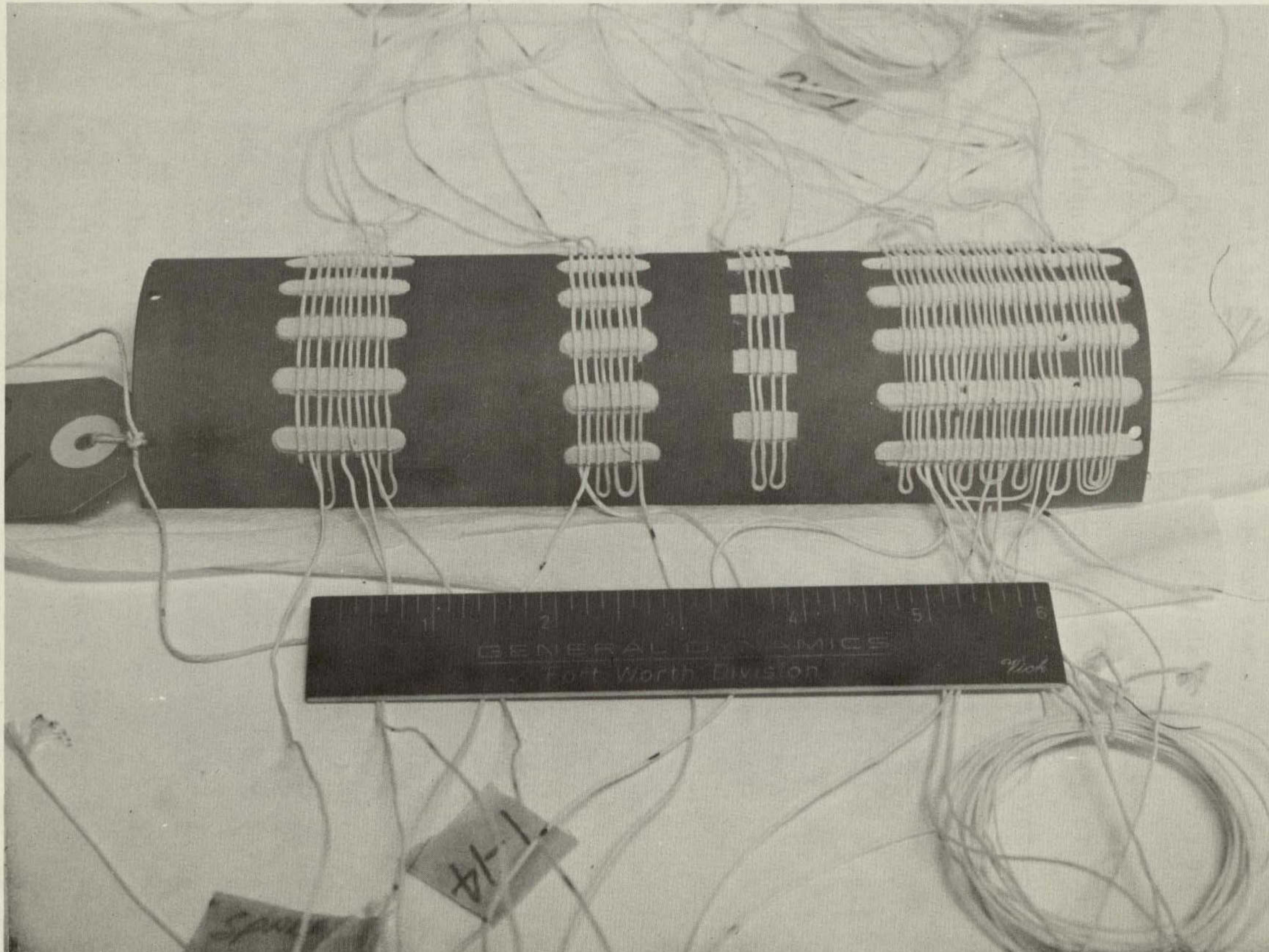

Figure 2-3 Representative Specimen Shield

shield was of a thickness which depended upon the diameter of the specimen with which it was to be used. Because of the fragile nature of the graphite shield, a 0.020-in.-thick stainless-steel shield was used to back up the graphite and give it additional support. To prevent contact between the steel and graphite, a 0.003-in. layer of mica was sandwiched between them. In the graphite unit, all tempering of the thermocouple leads was to the back of the steel shield rather than to the graphite.

Figure 2-4 shows a representative reference ring. The ring was used to reference all specimen thermocouples to the cryogen bath. As in the case of the specimen thermocouples, which were tempered to the shield, the reference thermocouples were tempered to the reference ring in the vicinity of the thermocouple junctions.

Figures 2-5 through 2-13 show representative thermal conductivity units in various stages of assembly. Figure 2-5 depicts the graphite specimen and one half-shield attached to the unit lid; the reference ring has not been attached. Figure 2-6 shows one of the beryllium units with the shield heater attached to one half of the beryllium shield. Figure 2-7 depicts the back side of one of the units before installation of the reference ring. Figure 2-8 shows the aluminum unit with the reference ring attached; the reference ring is clamped to the lid with three screws. An indium gasket, 0.020 in. thick, between the ring and

the lid enhances thermal contact between the reference ring and the lid. Figure 2-9 depicts the back side of a representative unit with the reference ring installed. Figure 2-10 shows a representative unit, complete except for the outer can assembly. The shield is wrapped with insulation consisting of one layer of aluminum foil sandwiched between two layers of high-density fiberglass. Figure 2-11 shows two of the completed units, less outer can assemblies; in this view the external risers from the unit lids can be seen, along with the VacIon pumps. Figures 2-12 and 2-13 depict all five units at various stages of assembly, including completed units.

For the electrical resistivity measurements on the thermal conductivity specimens, current leads were attached to each end of the specimen (at the specimen heater and the test-unit lid). Voltage sense leads were attached to the top (T/C 1) and bottom (T/C 3) thermocouple clamps. The voltage sense leads were made of 5-mil copper wire.

2.3 Experimental Equipment

2.3.1 Experimental Assembly

The experimental assembly used for this test is shown in Figures 2-14 through 2-19. Figure 2-14 is a view of the assembly as seen from the reactor. The shroud door is open, showing the isothermal terminal boxes where all test leads from the specimen test units mated with the leads from the instrumentation. The

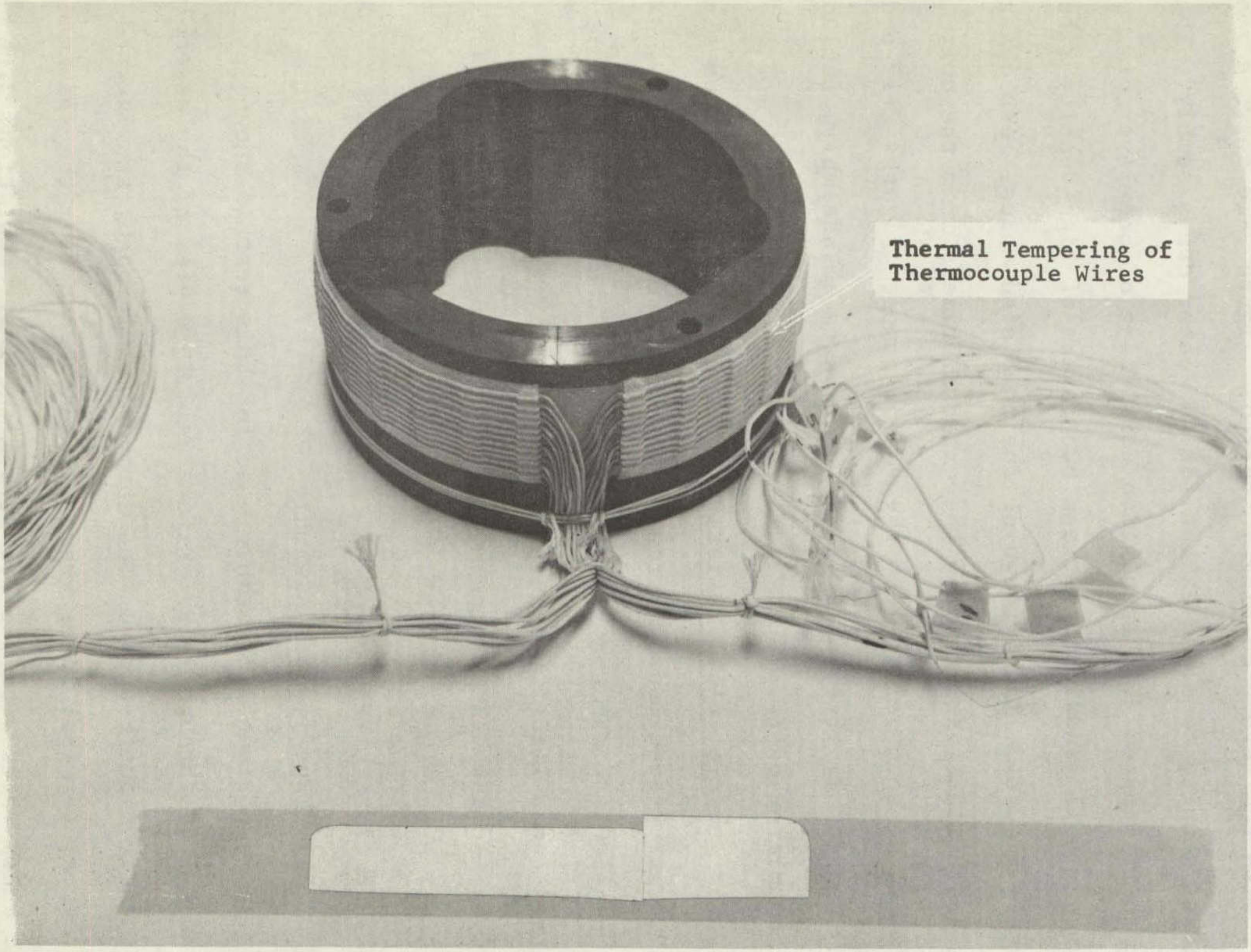

Figure 2-4 Reference Ring of Thermal Conductivity Unit

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31-9010

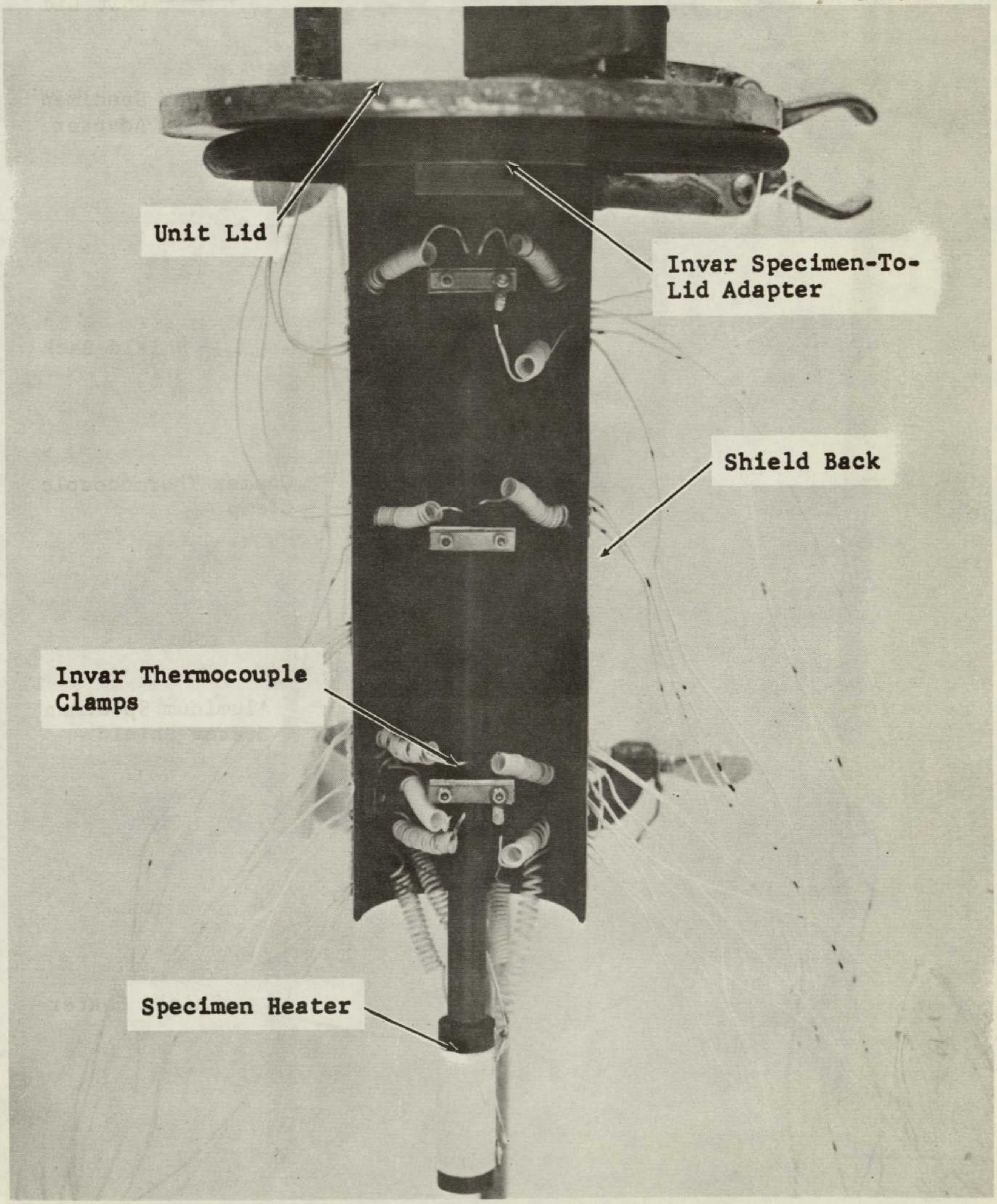

Figure 2-5 Front View of Partially Assembled Thermal Conductivity Unit for Graphite Specimen

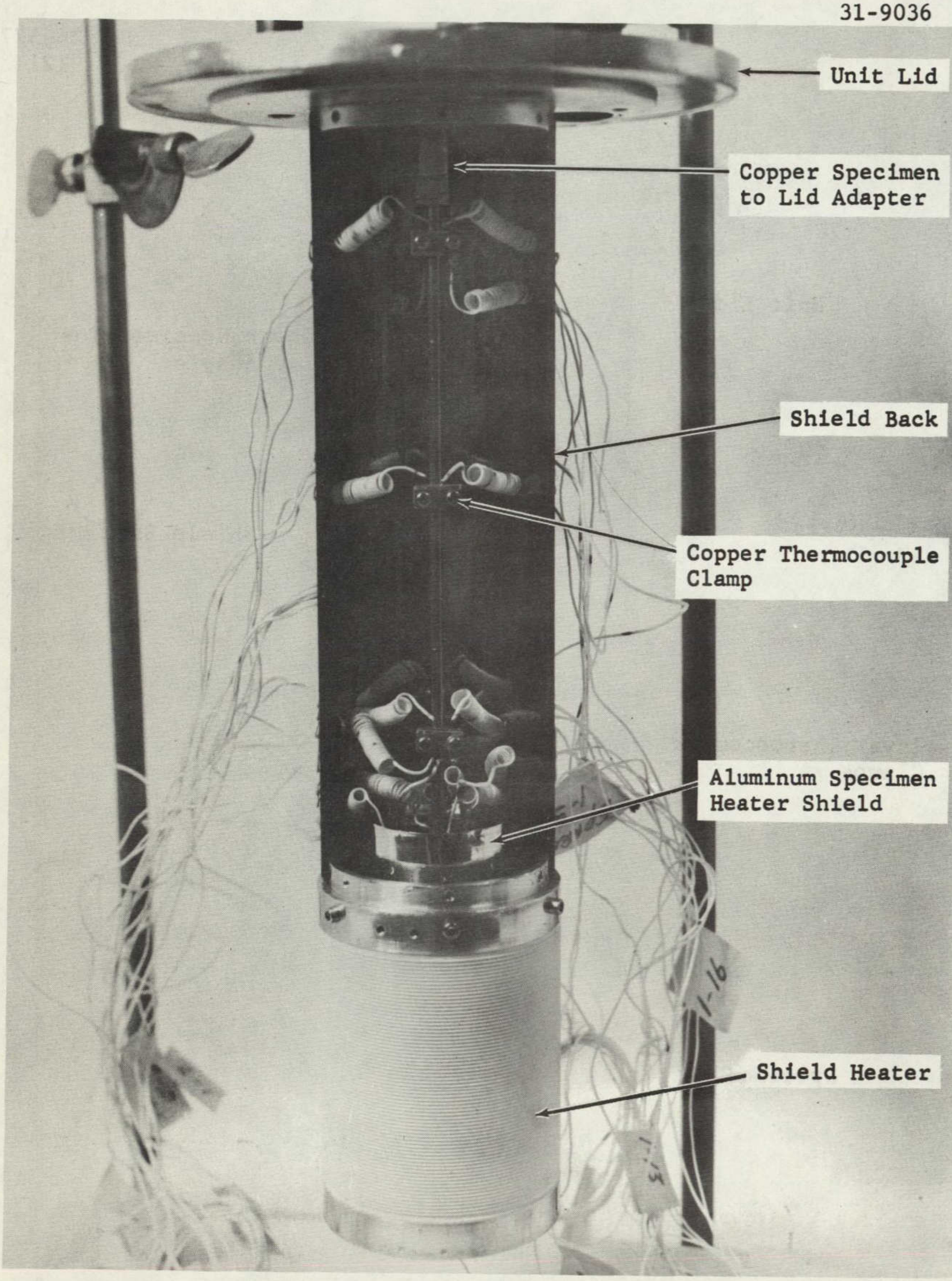

Figure 2-6 NBS Beryllium Thermal Conductivity Unit

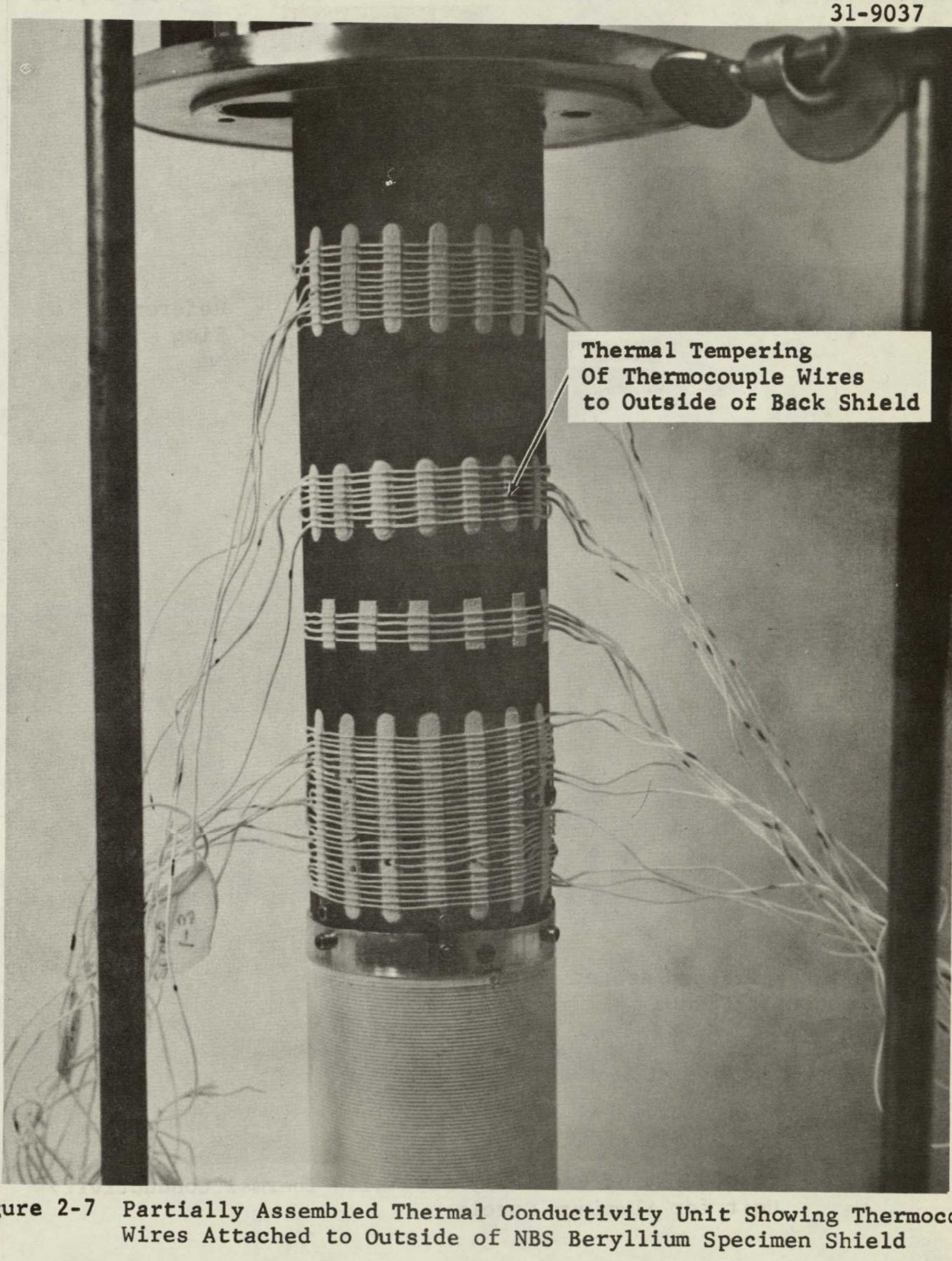

Figure 2-7 Partially Assembled Thermal Conductivity Unit Showing Thermocouple Wires Attached to Outside of NBS Beryllium Specimen Shield

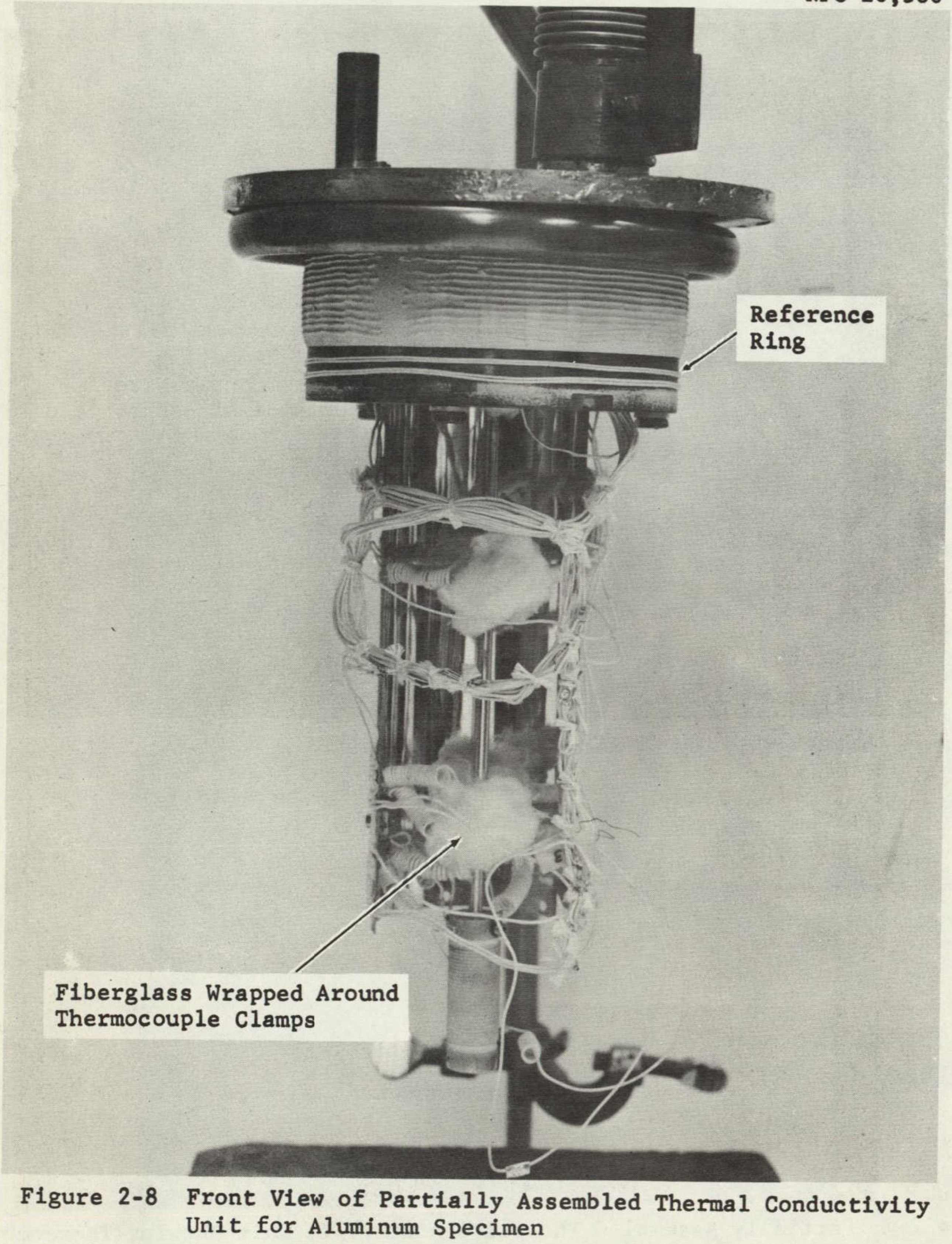

Figure 2-8 Front View of Partially Assembled Thermal Conductivity Unit for Aluminum Specimen

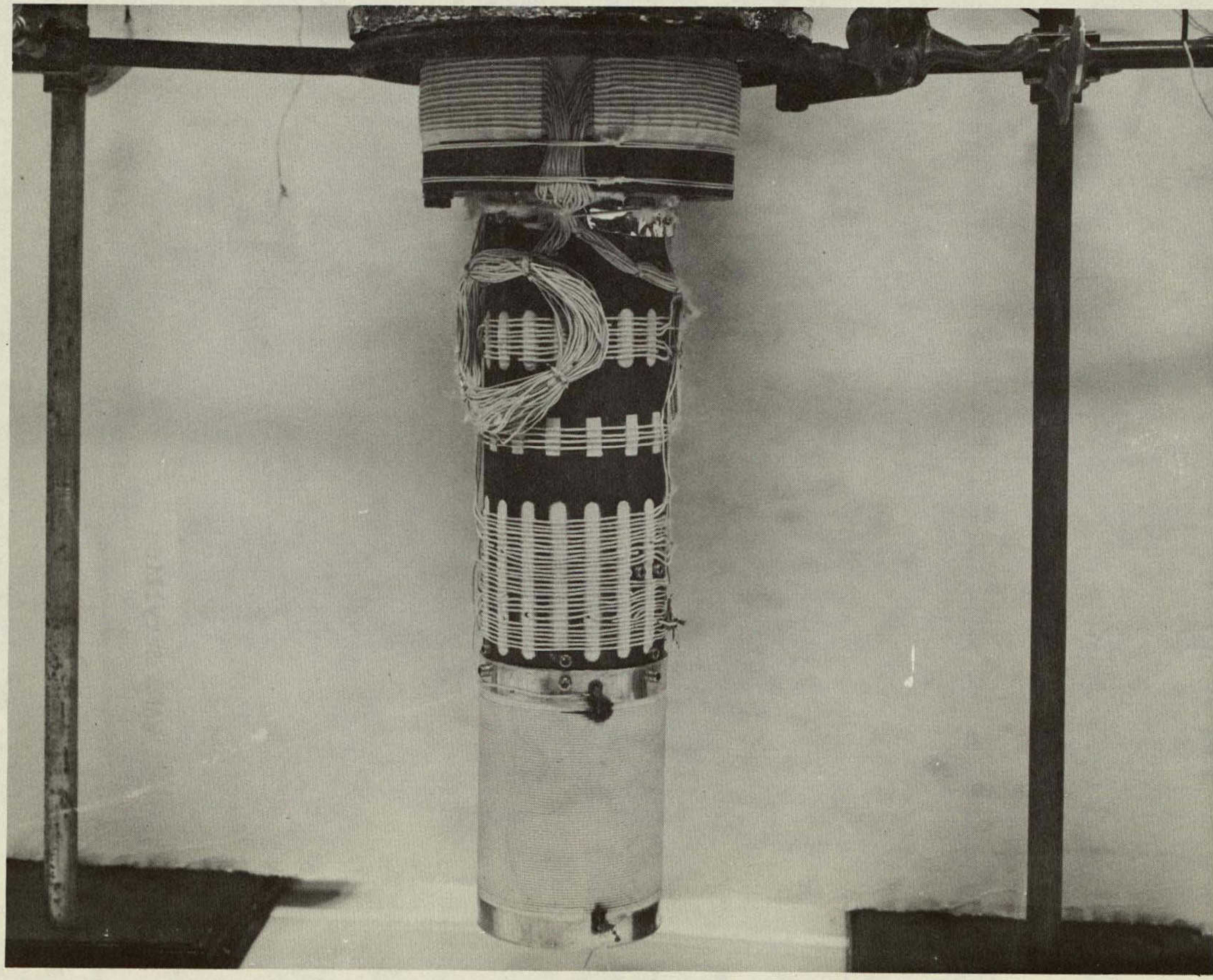

Figure 2-9 Thermal Conductivity Unit with Internal Wiring Completed

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31-9063

Figure 2-10 Completed Internal Assembly of Thermal Conductivity Unit

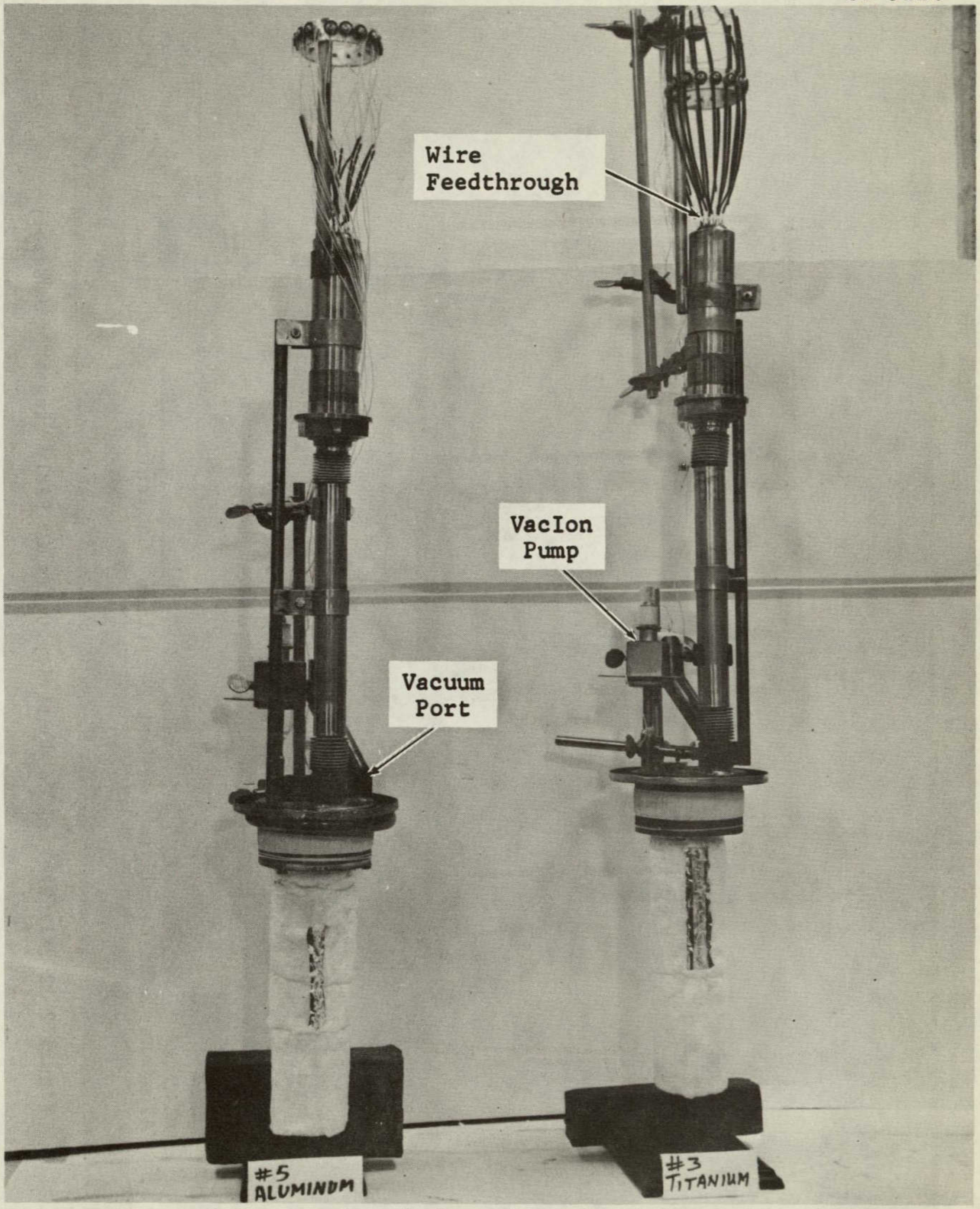

Figure 2-11 Completed Thermal Conductivity Units Minus Outer Can Assembly

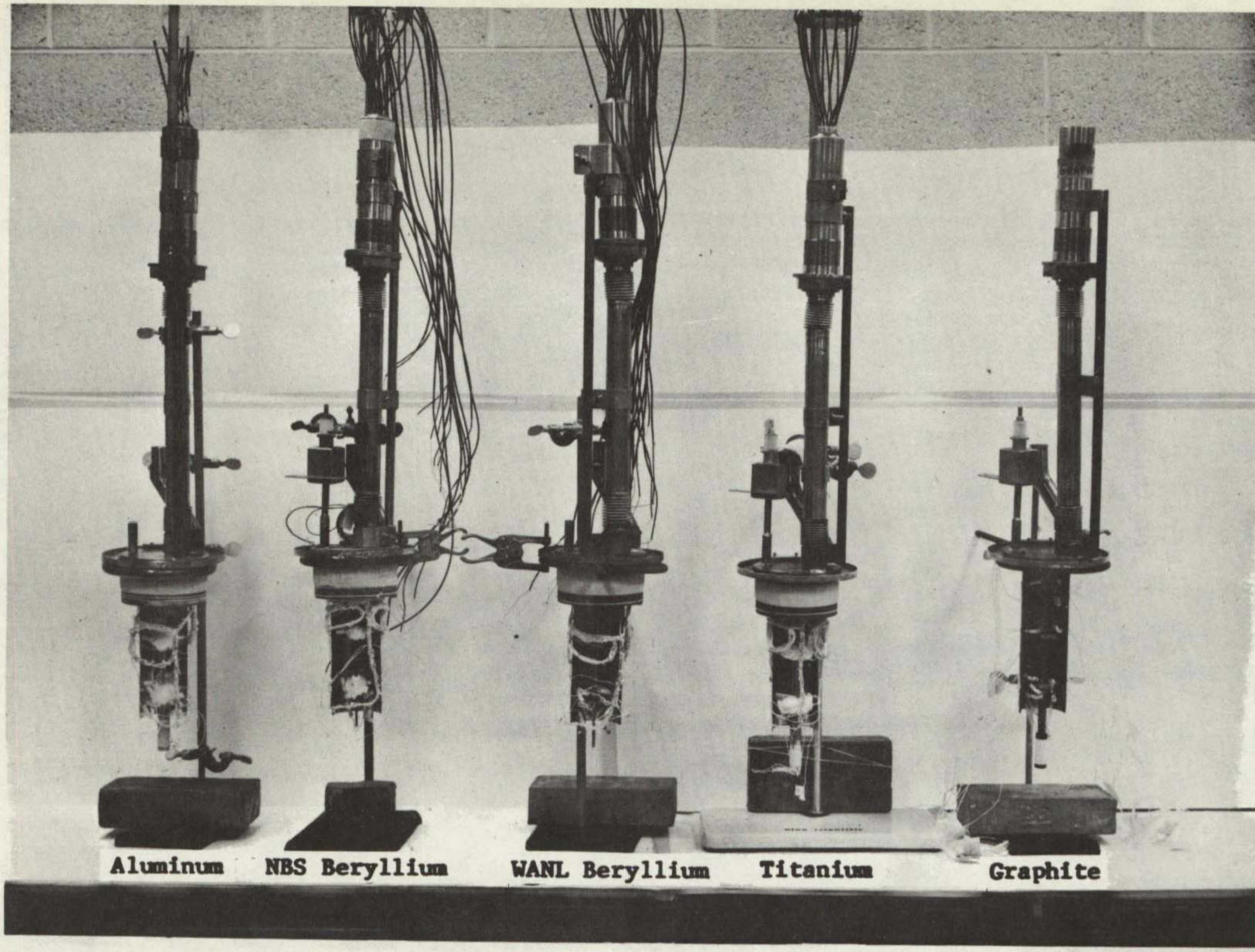

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Figure 2-12 All Thermal Conductivity Units in Early Stages of Assembly

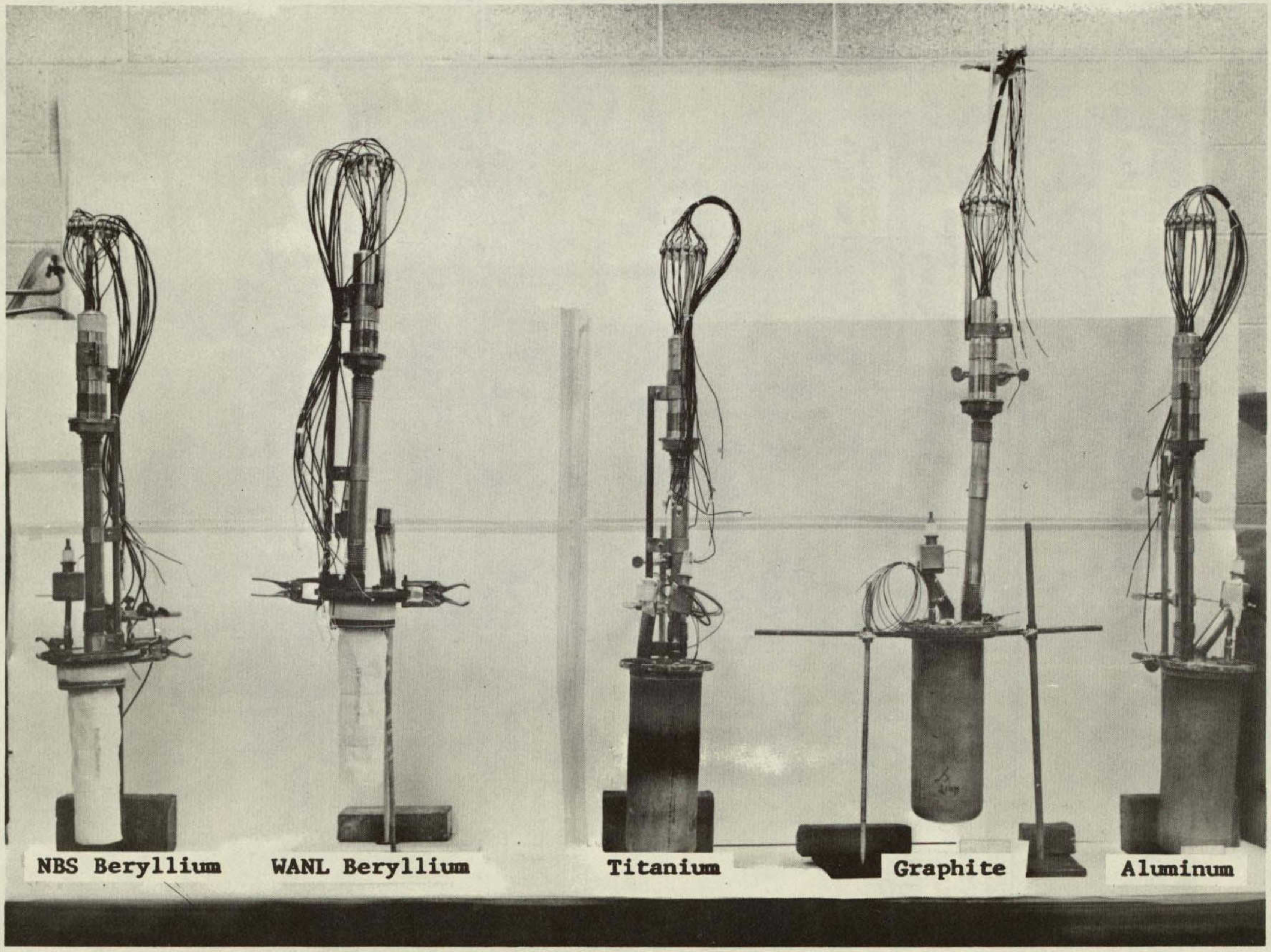

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Figure 2-13 All Thermal Conductivity Units in Later Stages of Assembly

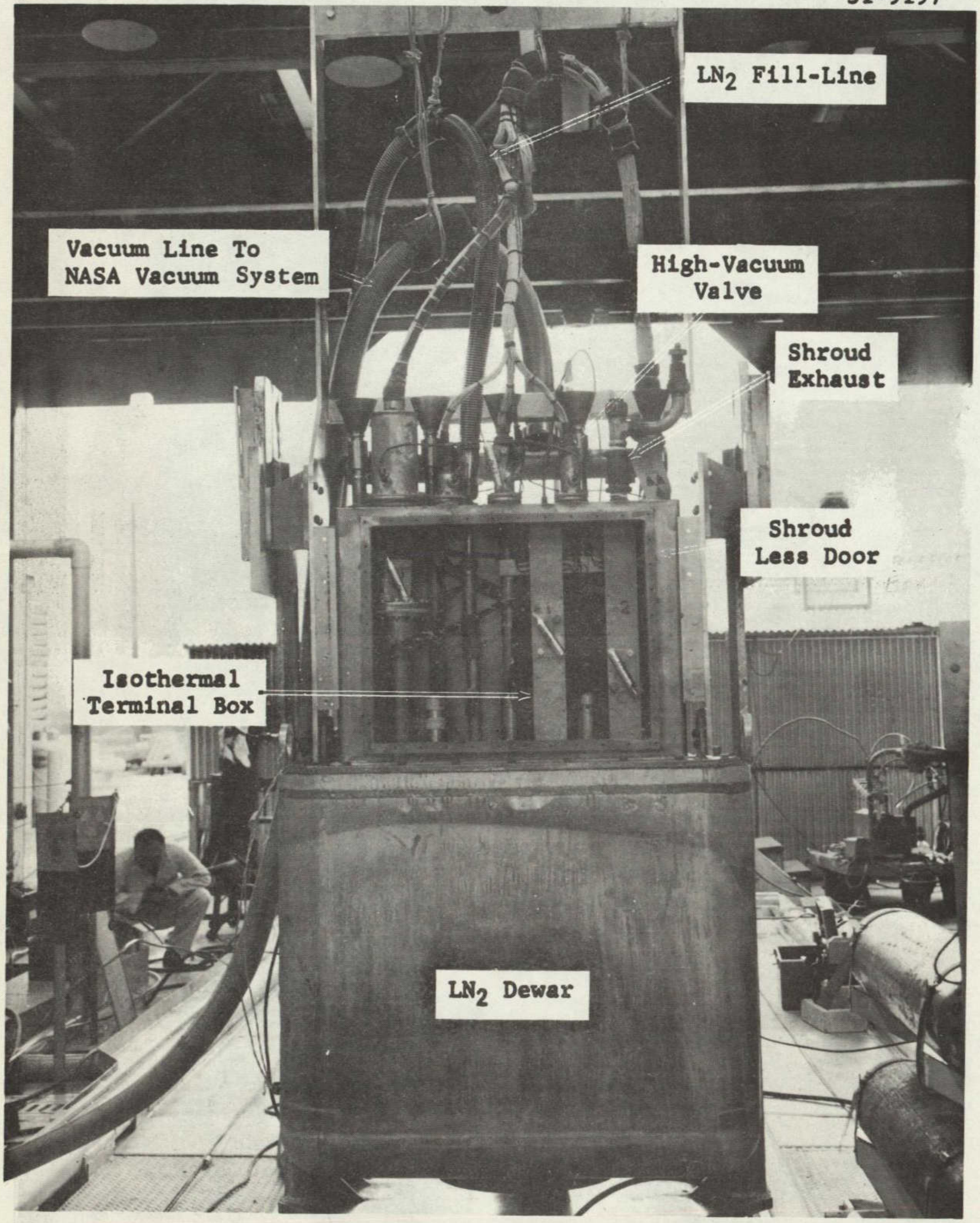


Figure 2-14 Front View of Experimental Assembly (Reactor Side)

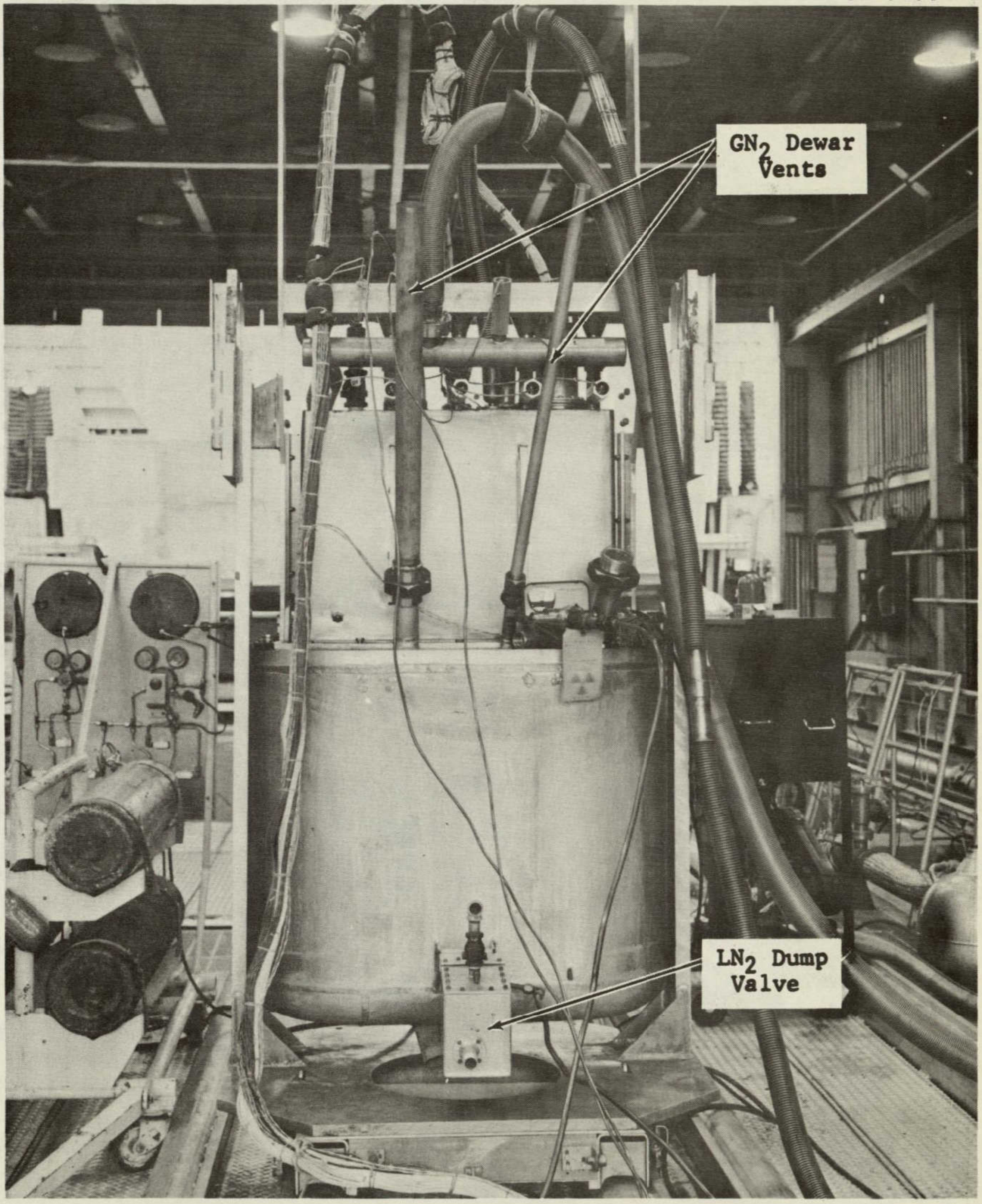
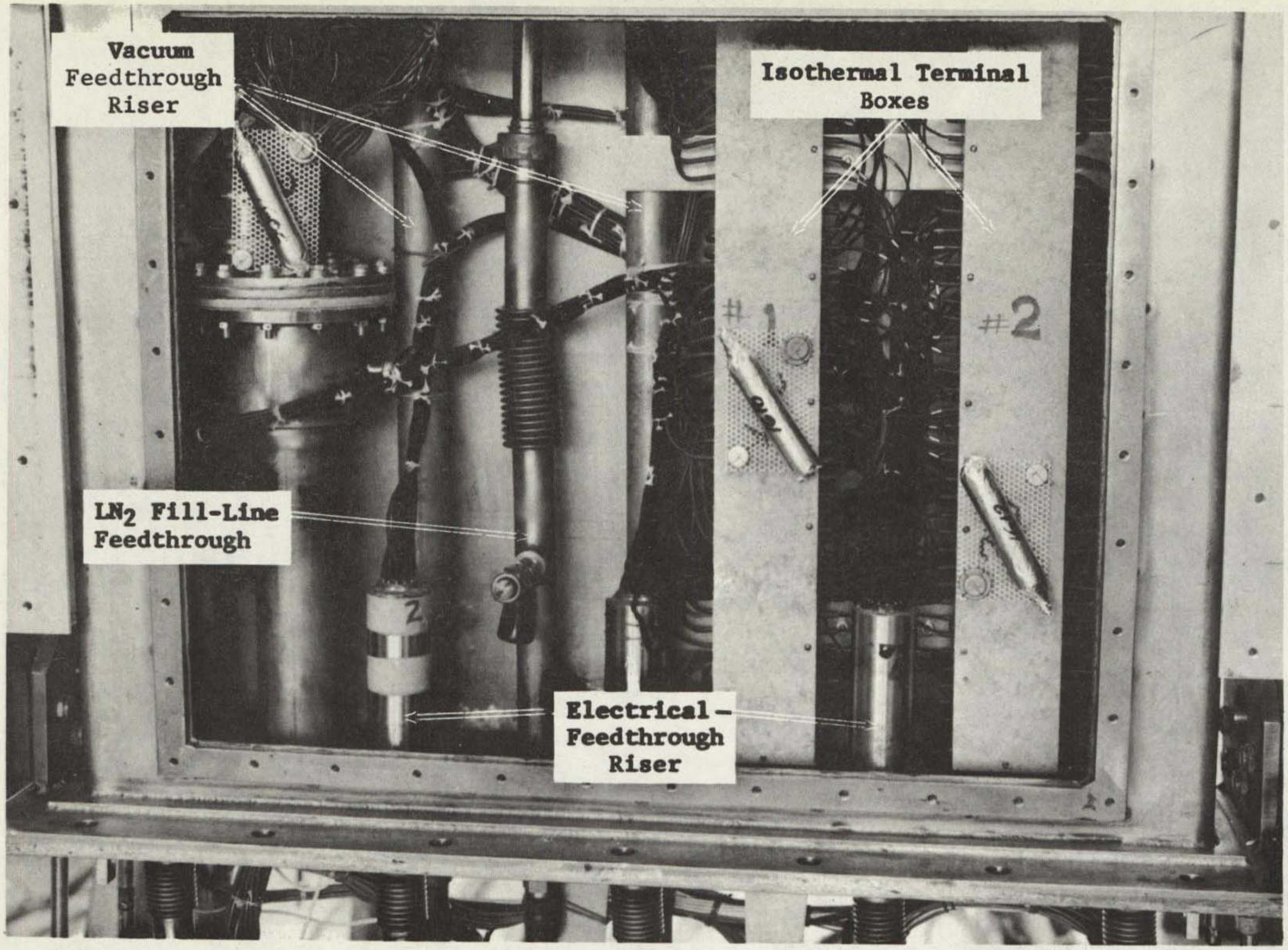


Figure 2-15 Rear View of Experimental Assembly



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31-9186

Figure 2-16 View of Wiring Enclosed by Shroud

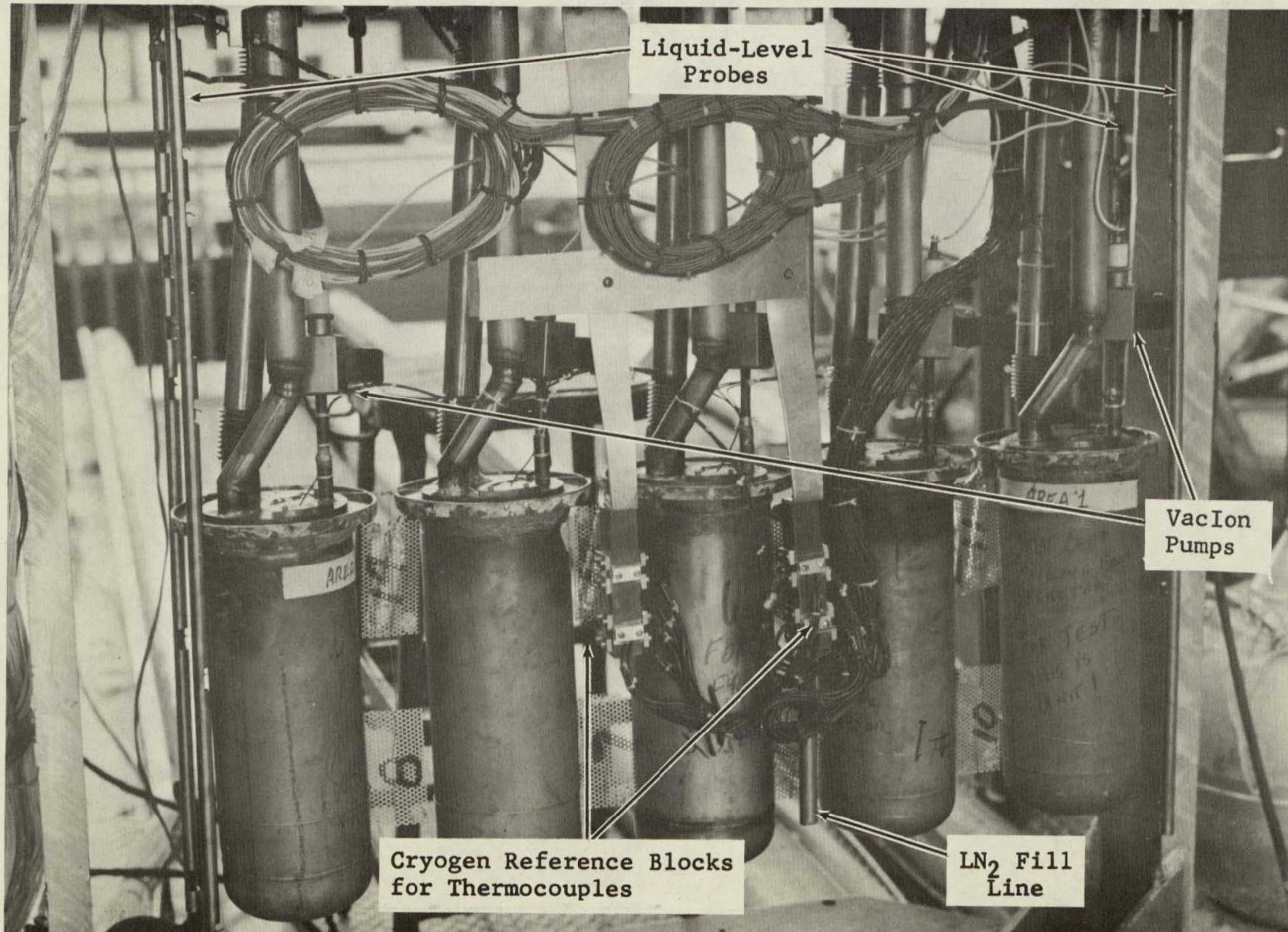

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Figure 2-17 Thermal Conductivity Units Welded into Experimental Assembly

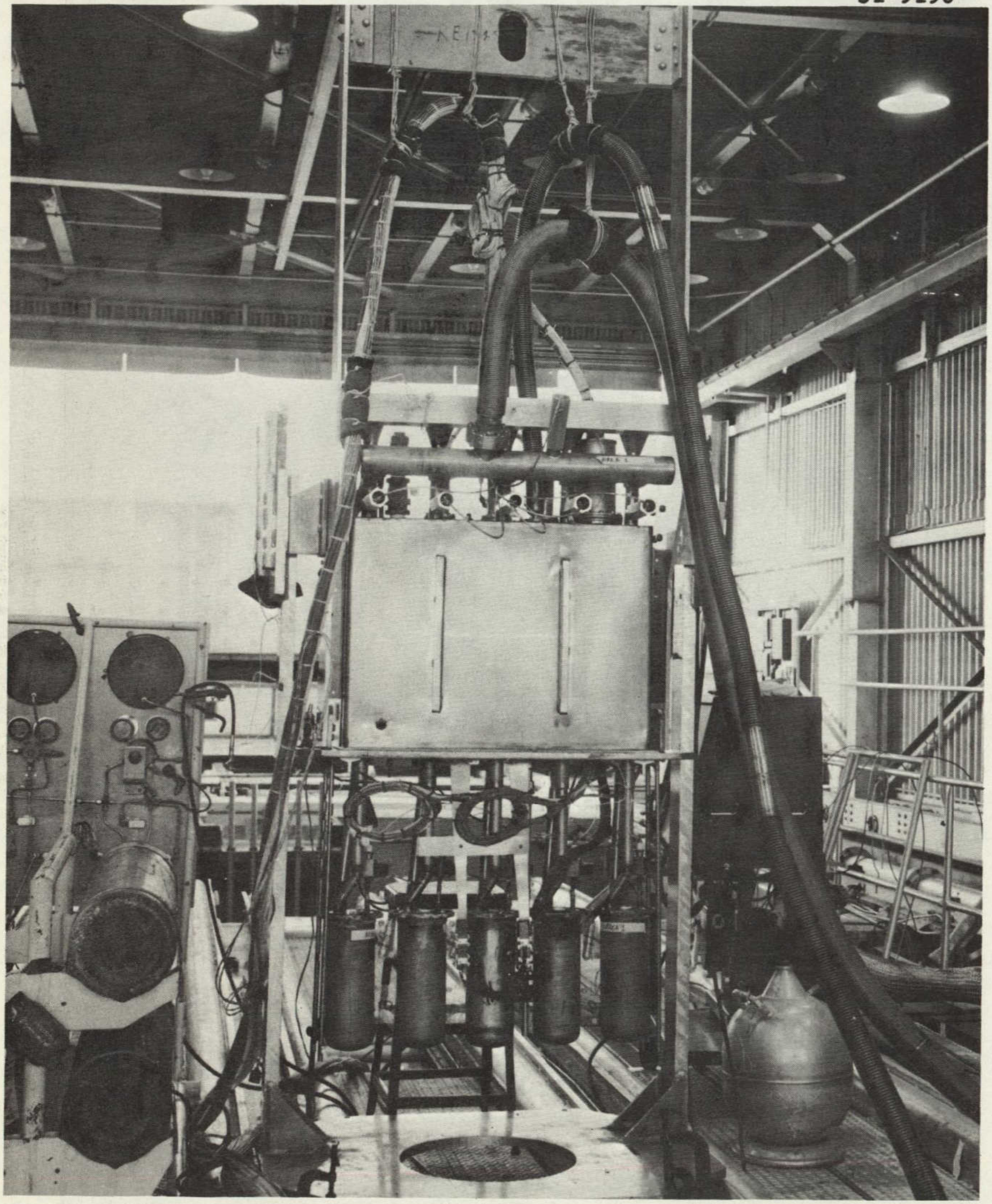

Figure 2-18 Experimental Assembly Minus LN_2 Dewar

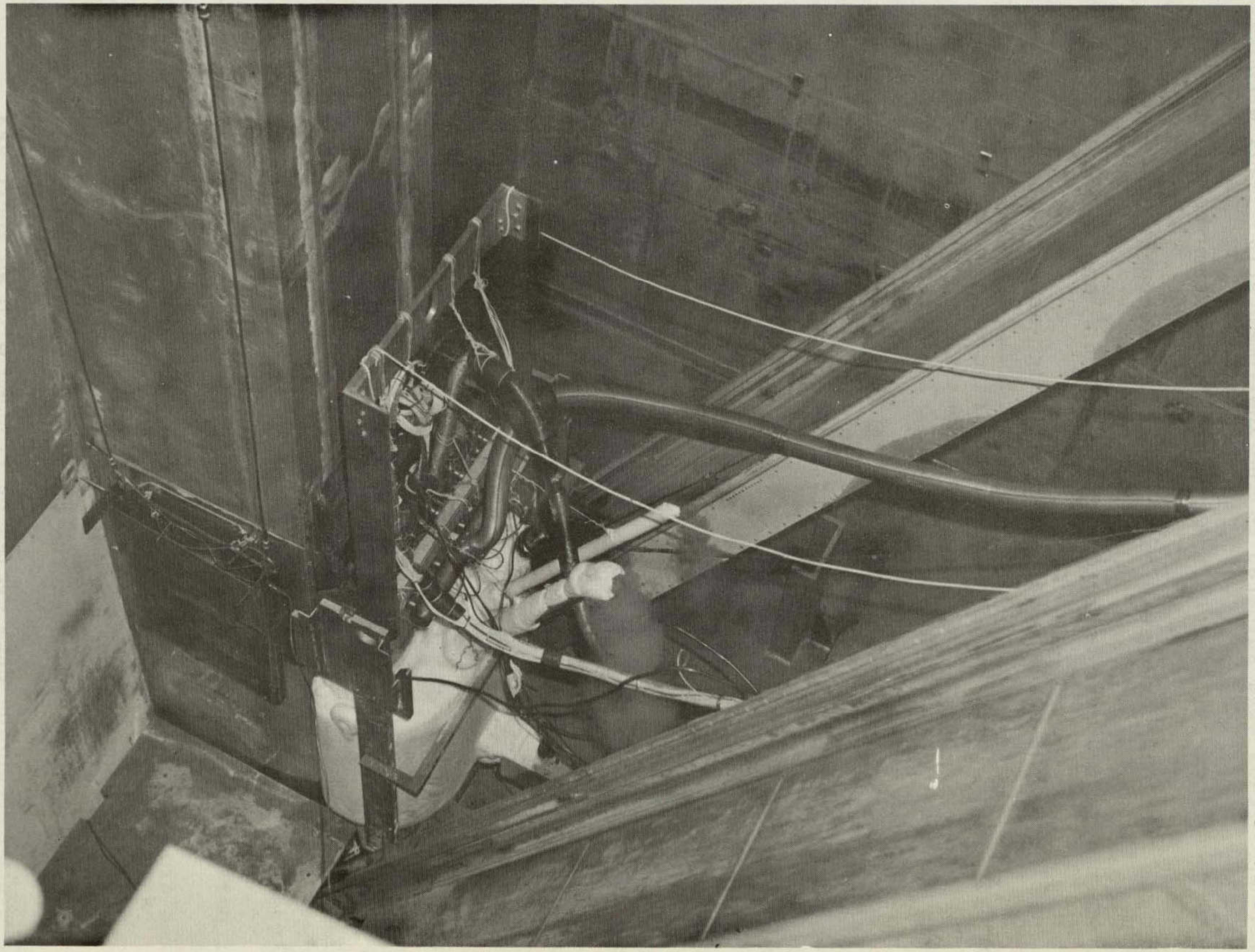

Figure 2-19 Experimental Assembly in North Irradiation Position

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test-unit leads were soldered to the instrumentation leads with low-emf solder. All leads from the instrumentation to the isothermal terminal boxes were of shielded thermocouple-grade copper Raychem wire and were approximately 130 ft in length. The isothermal terminal boxes were packed with high-density fiberglass to provide an isothermal environment. Figure 2-15 shows the rear of the experimental assembly. Figure 2-16 is a close-up view of the shroud showing the internal wiring and location of shroud dosimetry packets. Figure 2-17 is a close-up view of all test units welded into the assembly and shows the internal wiring, liquid-level probes, and dosimetry packets. Figure 2-18 is a rear view of the assembly with the dewar removed. Figure 2-19 is a view of the assembly in irradiation position during the preirradiation data cycle.

A lead and water shield was bolted to the front of the dewar shroud to shield the wiring inside. The shield consisted of a steel tank 1.44 in. thick by 44 in. high by 28.1 in. wide. A slab of lead, 1 in. thick by 27 in. high by 25 in. wide, was placed inside the tank and the tank was filled with water. The proper water level was maintained during the irradiation by means of a float valve.

2.3.2 Vacuum System

The test plan required the capability that each unit could be evacuated during data cycles or flooded with an inert gas

during irradiation. The valves and piping used to accomplish this can be seem in Figures 2-14 through 2-19 of the preceding section. One of the NASA vacuum irradiation systems (Fig. 2-20) was used to rough-pump the vacuum lines and test units to below 10^{-3} mm-Hg so that the VacIon pumps could be started. The 1-liter/sec VacIon pumps (Varian Model 913-0007) were an an integral part of each test unit, as can be seen in Figure 2-11, and were used to obtain a vacuum of less than 10^{-4} mm-Hg. The VacIon pumps were instrumented with 130-ft leads of Raychem high-voltage cable, proof-tested to 10,000 V. A 1.5-in. vacuum line was attached to each test unit from a 3-in. header located at the top rear of the assembly shroud. The 3-in. header was attached to the vacuum system through a 3-in. vacuum line 40 ft long. A high-vacuum valve mounted outside the shroud was incorporated in each of the 1.5-in. vacuum lines to the test units. With the system in the irradiation position (Fig. 2-19), it was necessary to manually operate these valves from the top of the pool shield with extension tools when flooding the units or when evacuating them.

2.3.3 Instrumentation

Cryogen-Level System. A liquid-level system was incorporated to continuously monitor and control the liquid level in the dewar. This system consisted of four liquid-level probes - two resistor probes and two thermocouple probes, one of each being a primary and the other a back-up. Each probe contained seven sensors

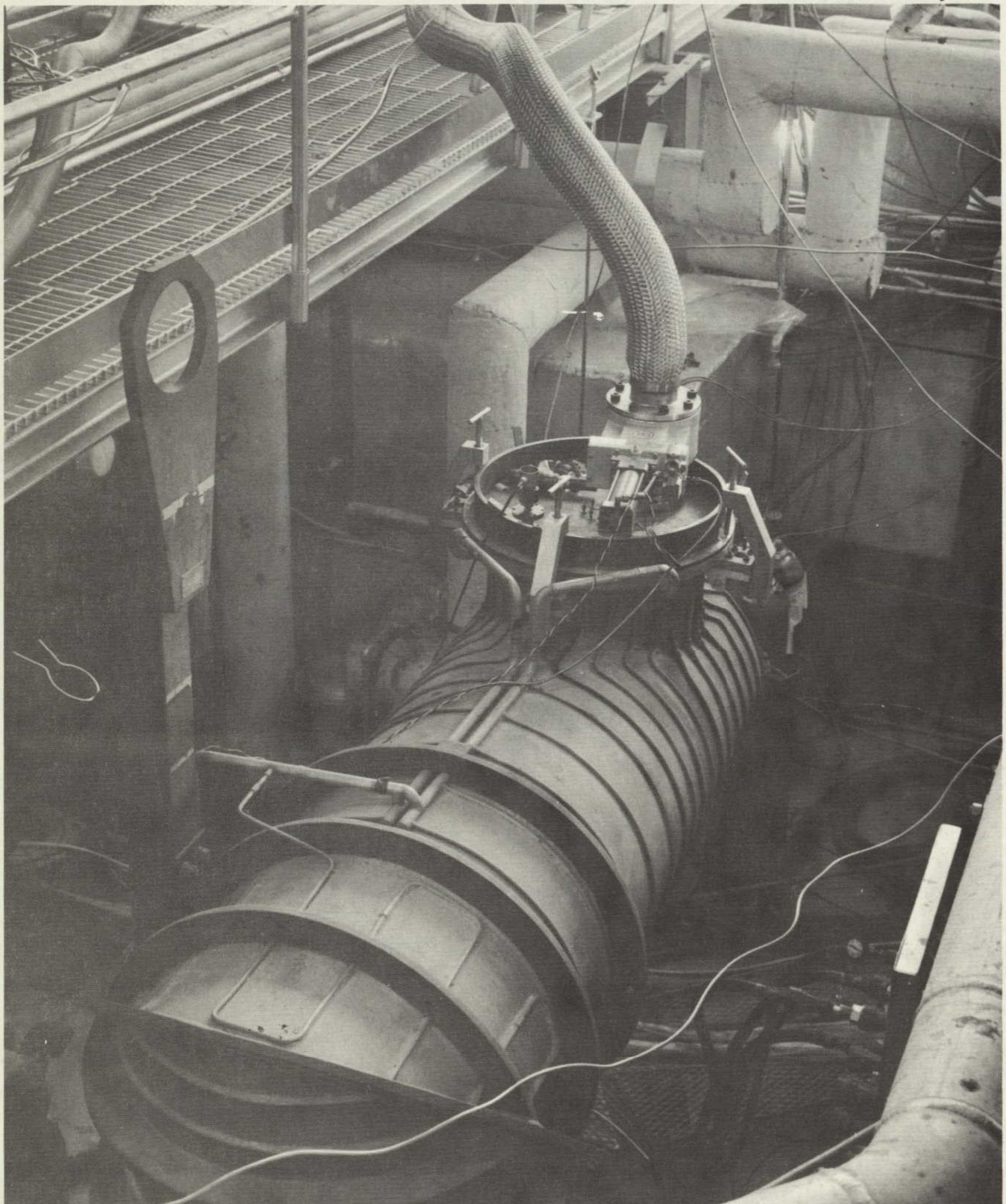

Figure 2-20 NASA Vacuum System

(carbon resistors or copper/constantan thermocouples) mounted in a rake and spaced 29.0, 20.5, 12.0, 10.0, 8.0, 6.0, and 4.0 in. below the underside of the dewar lid. The resistor probe was used with an indicator panel that indicated the liquid level in the dewar; the thermocouple probe was used in conjunction with a Bristol control unit to control the level in the dewar. The outputs of the thermocouples were converted by the Bristol controller to a pneumatic signal which was used to operate a Fischer Proportional Positioner mounted on the LN_2 cryogen supply valve.

Pressure-Transducer Instrumentation. A CEC differential pressure transducer ($\pm$ 5 psid) was used to monitor the dewar pressure, referenced to atmospheric pressure. The pressure transducer was calibrated prior to the test and its output was monitored throughout the test with the Dymec data system, which employs a five-place digital readout. The barometric pressure was recorded in mm-Hg from a calibrated Wallace and Tiernan Model FA 145 pressure gage. The difference between dewar pressure and atmospheric pressure proved to be negligible throughout the test because of the large GN_2 vents employed on the dewar.

Thermal Conductivity/Electrical Resistivity Instrumentation. The voltage measurements required for thermal conductivity and electrical resistivity determinations were made with a Leeds and Northrup K-3 potentiometer facility in conjunction with associated switching and electrical circuits. Figure 2-21 depicts all

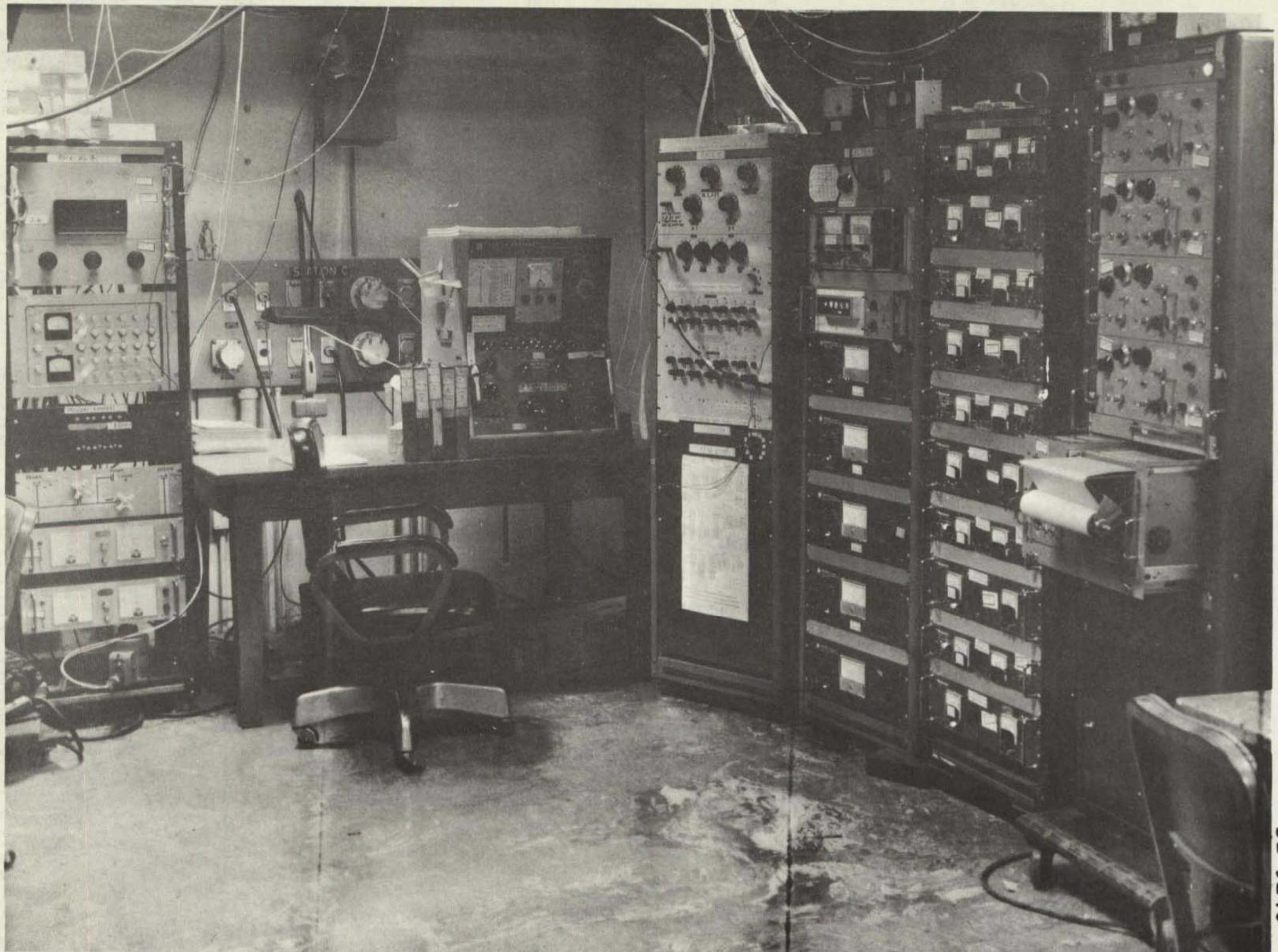

Figure 2-21 Thermal Conductivity Instrumentation

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instrumentation used, with the exception of the Dymec data system. The power to the specimen heaters and the shield heaters was supplied by Kepco power supplies, Models SM 75-2 AM and SM 325-1 AM, respectively. Figure 2-22 is a simplified schematic of the thermal-conductivity electrical setup. Since the test leads connecting the instrumentation to the thermal conductivity units were approximately 130 ft long, voltage-sensing leads were used on the specimen heaters in order to measure the voltages accurately at the heater terminals. The heater currents were determined by measuring the voltage drops across precision resistors in the heater circuits. Both the heater voltages and the voltage across the resistors were measured with a Dana digital voltmeter.

Figure 2-23 is a simplified schematic of the electrical resistivity setup. The current to the specimens was supplied by a Hewlett Packard Model 6226A power supply.

2.4 Test Procedures

2.4.1 Prototype Test

Two prototype test units incorporating NBS standard beryllium specimens were constructed and completely checked out before initiating construction of the final test units. During construction and testing of the prototypes, several modifications to the heaters were made before workable ones were obtained. The prototype units were checked out completely over the temperatures ranging from 77.4^{o}K to 180^{o}K. A comparison of the data obtained

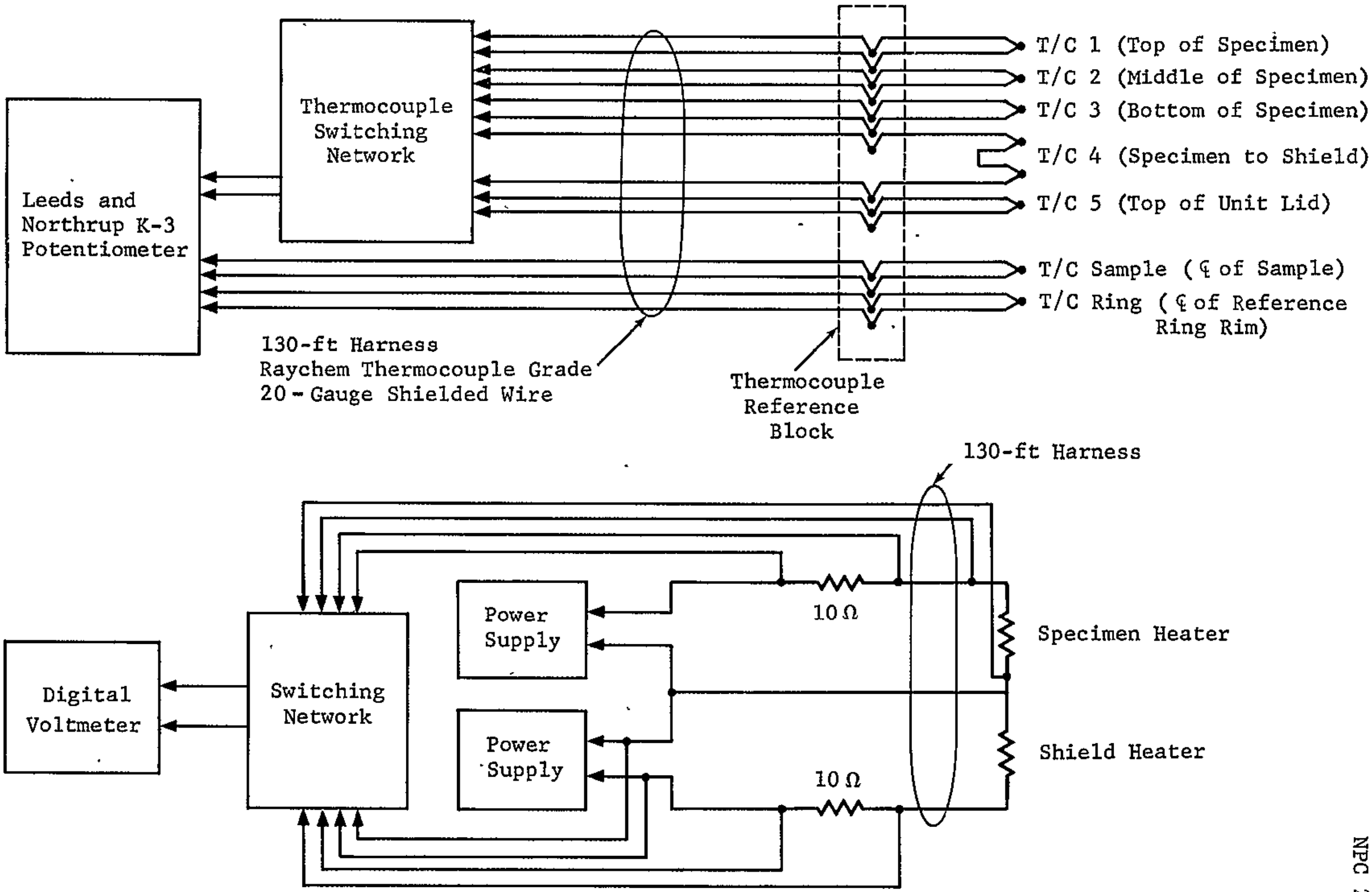

Figure 2-22 Thermal-Conductivity-Test Electrical Setup

NPC 26,726

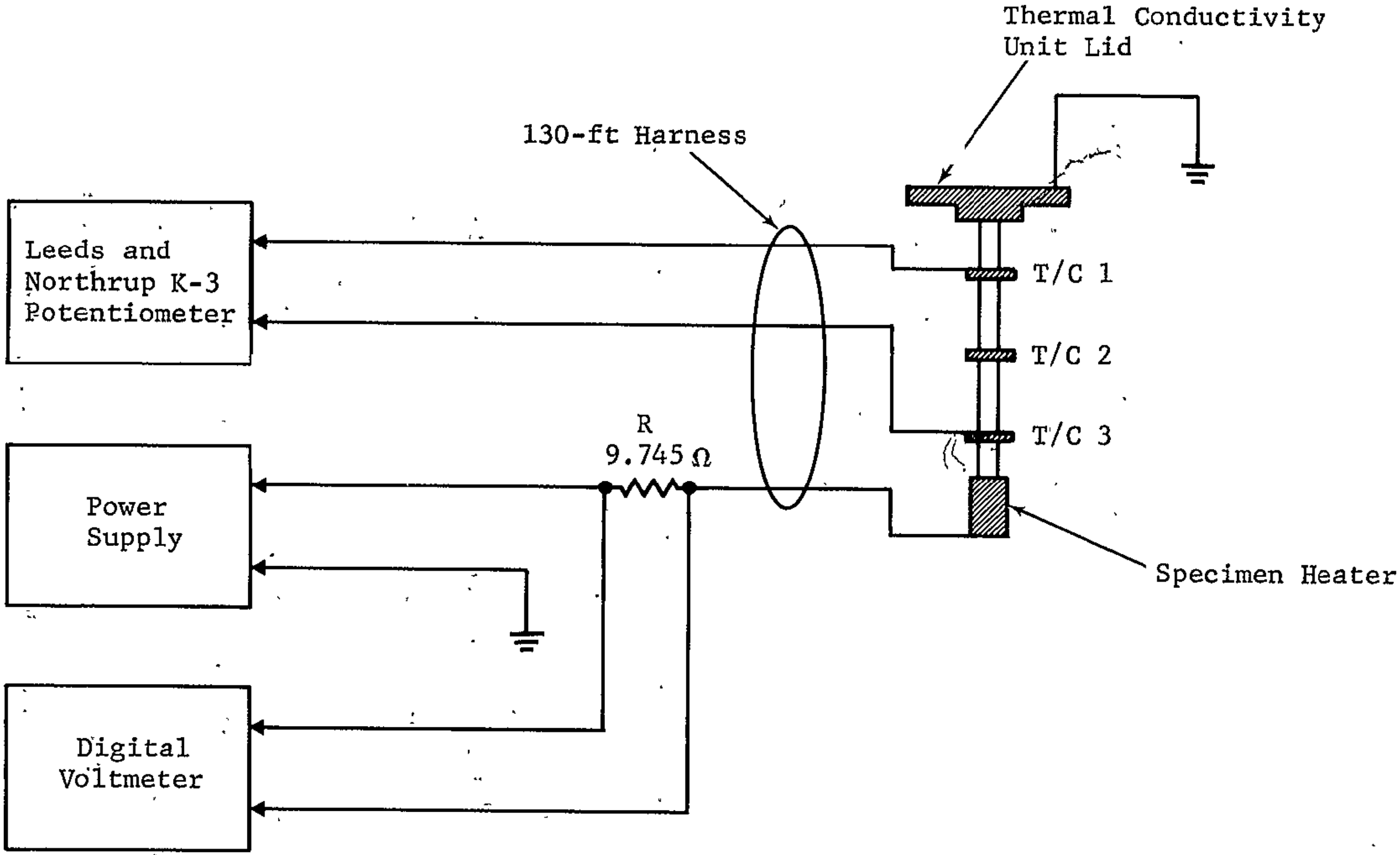

Figure 2-23 Electrical Resistivity Test Setup

on the prototype units with data previously obtained on these specimens by NBS over the applicable temperature range indicated that the data correlation was within 8.0% (see Fig. 2-24).

Construction of test units to be irradiated in GTR 21 was then initiated. Ten units were to be irradiated, five in LN_2 and five in LH_2; this was later changed to five units in LN_2 only. Since the LH_2 shroud assembly had been completed and was used in the testing of the prototype units, this assembly was used for the irradiation test and fabrication of the LN_2 shroud assembly was terminated.

2.4.2 Preirradiation Test

The operational sequence for the thermal conductivity test is illustrated in Figure 2-25. With the five thermal conductivity/electrical resistivity test units installed in the experimental assembly, LN_2 flow into the dewar was initiated. After the initial checkout procedures were completed, the test units were evacuated and allowed to come to thermal equilibrium at zero heater power. The test specifications stated that thermal equilibrium would exist when the outputs of all thermocouples inside the test apparatus remained constant with $\pm$ 1 μV for a minimum of 1 hour. At thermal equilibrium with no heater power applied, small thermocouple outputs were due to thermal emfs generated in the test leads. In general, these outputs were less than 2 μV

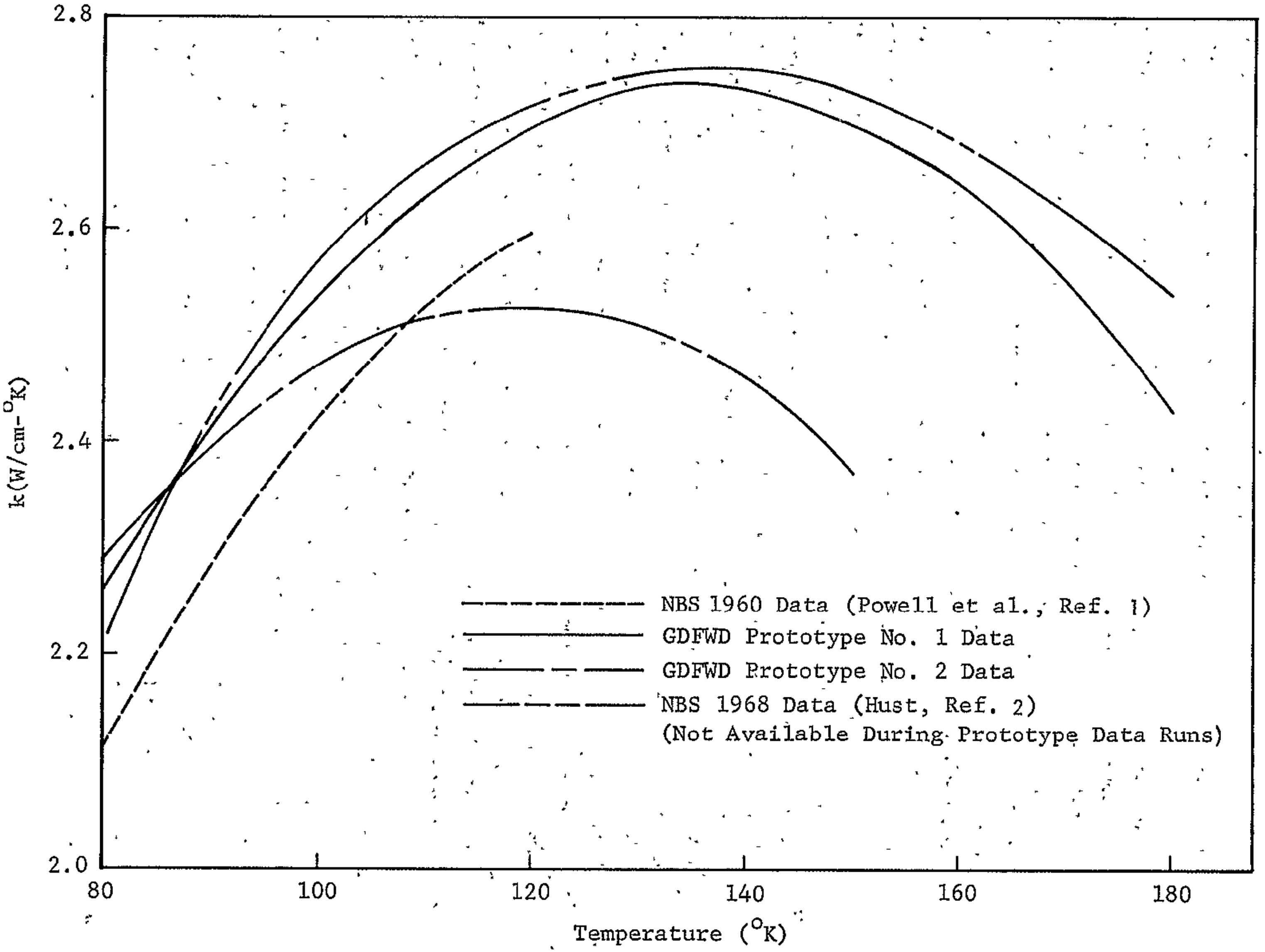

Figure 2-24 Comparison of GDFWD Prototype and NBS Thermal Conductivity Data for Beryllium

NPC 27,304

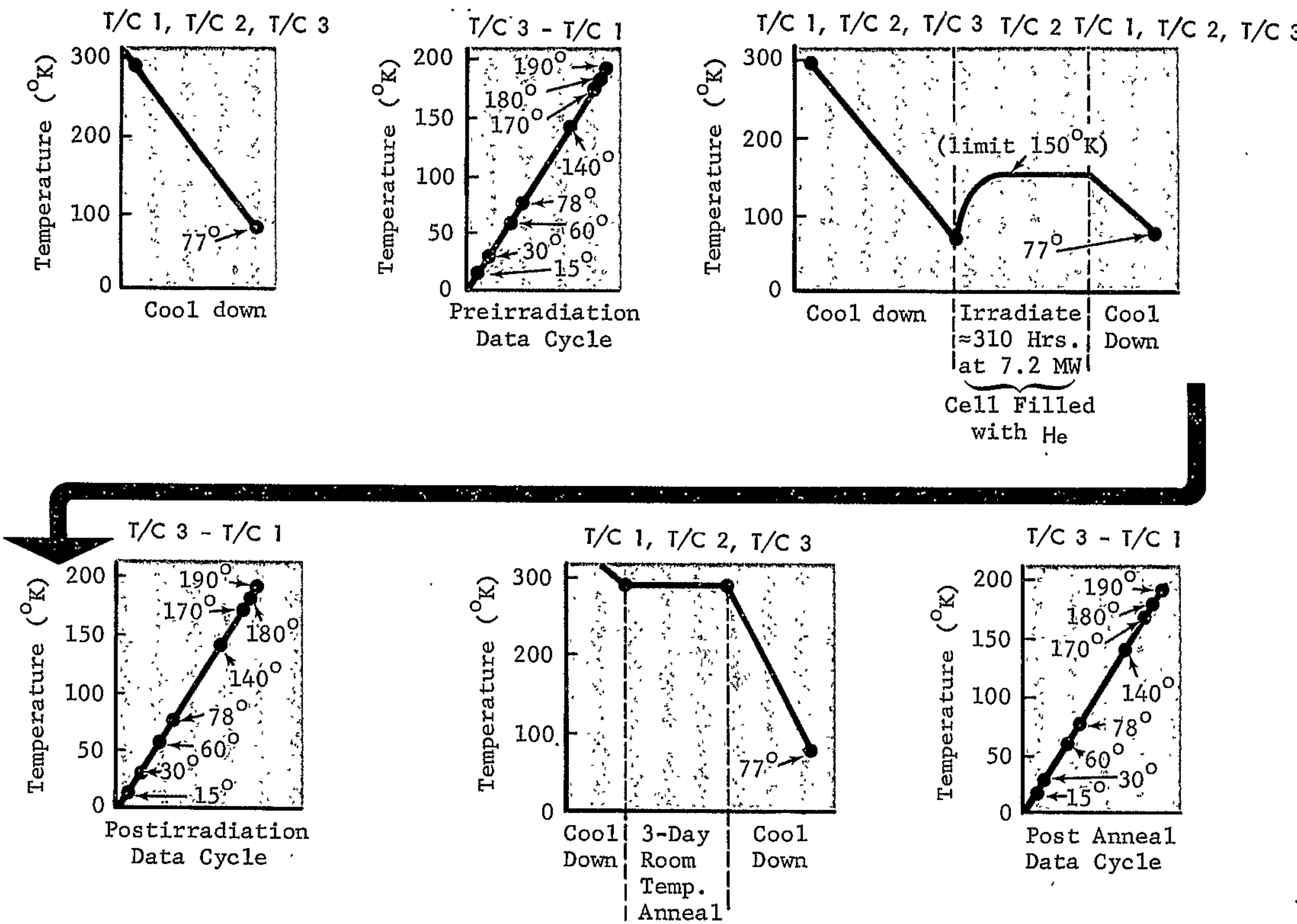

Figure 2-25 Operational Sequence of the Thermal Conductivity Test

NPC 27,305

except for the titanium unit which indicated a maximum of 4.2 μV.

After zero-power thermal equilibrium was achieved, electrical resistivity data were taken. This was accomplished by first measuring the thermoelectric force of the specimen relative to the thermocouple clamps and sense leads with zero current flow through the specimen. The potential developed across a given length of the specimen (140 mm) with a known current flow through the specimen was measured to determine the electrical resistance of the specimen. The current direction was then reversed and the potential developed in this reverse direction was measured. From these measurements and the known area and length of the specimen, the resistivity at zero-power thermal equilibrium (77.4°K) was determined.

After completion of the above steps, the thermal conductivity and electrical resistivity of each specimen was determined for the temperature gradients specified in the test specification (Ref. 3). However, the maximum specified temperature gradients could not be reached for all the specimens because of limitations on maximum heater power. To avoid burnout of the heaters, the maximum usable power was determined in tests conducted in the laboratory on individual heater elements prior to the startup of the thermal conductivity test.

To establish the desired temperature gradient, the power to the specimen heater and shield heater was adjusted until the

approximate temperature gradient was attained. The power to the shield heater was then adjusted until the output of the differential thermocouple (T/C 4) between the specimen and its sheild was less than $\pm$ 12 μV, corresponding to a temperature differential of less than 0.50^{o}K at LN_2 temperature. The specimen-heater power was maintained at a constant level until thermal equilibrium was obtained. During this time, adjustments were made only in the shield-heater power to maintain the output of T/C 4 at $\pm$ 12 μV. Thermal equilibrium at power was considered achieved when the specimen thermocouple outputs remained constant to within $\pm$ 1 μV or $\pm$ 0.5%, whichever was greater, over a period greater than 1 hour. Once thermal equilibrium was obtained for some given temperature gradient, thermal conductivity and electrical resistivity data were recorded according to standard procedures. After completion of both thermal conductivity and electrical resistivity measurements, the power input to the specimen and shield heaters was increased to obtain the next desired temperature gradient. This procedure was repeated until all required data were obtained.

2.4.3 Irradiation Test

The test assembly was irradiated in the north irradiation position of the GTR test cell. The GTR test facility is briefly described in Appendix A. The reactor was operated for 2310 MWh at power levels ranging from 0.72 MW to 7.2 MW. Dosimetry procedures and data are given in Appendix B, and log of reactor

operation during the test is given in Appendix C.

No thermal conductivity data were taken during the irradiation. Prior to the start of the irradiation, the units were flooded to 1.5 atm of dry helium to improve heat transfer from the specimens to the cryogen bath during irradiation; this was necessary because gamma-ray heating of the specimens is a significant problem at higher reactor power levels. During the irradiation, the theromcouple outputs were monitored and recorded every hour with zero heater power. Electrical resistivity data were taken approximately every 4 hours during the irradiation. The reactor power level was adjusted during the irradiation to keep the specimen temperature, except for titanium, below 150°K as indicated by T/C 2. The maximum temperature for the titanium specimen was set at 175°K.

2.4.4 Postirradiation Test

The procedures for the postirradiation tests were the same as for the preirradiation tests except that additional tests were run to determine annealing characteristics of the materials. From the start of the preirradiation data cycles until the end of the postirradiation data cycles (after 2310 MWh of irradiation), the liquid nitrogen in the dewar was maintained at a level several inches above the lids of the thermal conductivity units. Upon the completion of the postirradiation data cycles, the liquid nitrogen was allowed to boil off and the dewar and test units

maintained at ambient temperature for a period of approximately 60 hours. After the ambient-temperature anneal, the dewar was again filled with liquid nitrogen and the thermal conductivity and electrical resistivity data cycles were repeated in accordance with the established procedures.

2.4.5 PO-3 Graphite Follow-On Test

The test procedure for the IML follow-on testing of the irradiated PO-3 graphite specimen was, essentially, the same as for the preirradiation test. The difference was in measuring thermal conductivity and electrical resistivity data to temperatures several hundred degrees higher in order to determine annealing characteristics of the specimen. This was done by using ice and boiling water reference baths, in addition to the LN_2 reference bath.

III. EXPERIMENTAL RESULTS

Thermal conductivity (k) and electrical resistivity (ρ) data were obtained from the five specimens before irradiation, immediately after irradiation, and after a 60-hour anneal at room temperature. Both the pre- and postirradiation data were taken with the experimental assembly in the irradiation position; the individual thermal conductivity units were submerged in the liquid nitrogen (LN_2) reference bath. It is important to note that from the time the preirradiation data cycles were initiated until after the postirradiation data cycles were completed, the test units were continuously submerged in the LN_2 reference bath.

The postirradiation anneal was performed by removing the LN_2 from the experimental assembly and allowing the units to warm to room temperature. After approximately 60 hours at room temperature, the experimental assembly, which was still in the irradiation position, was refilled with LN_2. The test units were allowed time to reach thermal equilibrium and the postirradiation anneal data cycle was initiated.

Several weeks after the postirradiation anneal data were taken, follow-on testing of the PO-3 graphite specimen was conducted. The specimen was removed from its assembly (which had a radioactivity level on the order of 200 R/h at contact) and installed in a new assembly. Data cycles were run using reference

baths of LN_2, ice water, and boiling water. These data cycles were made with and without fiberglass packing in the unit to determine the effect of thermal leakage.

Sections 3.1 through 3.4 contain detail descriptions of the data reduction techniques and error analyses used in this report. The following are definitions of the confidence and uncertainty limits as they are used in this report:

> Confidence Limits on Individuals - The interval having a fixed probability ($1-\alpha$) of containing future individual test values from the same population. It is based on the standard deviation of the individual test values.
>
> Confidence Limits on the Mean - The interval having a fixed probability ($1-\alpha$) of containing the true mean of future test values from the same population. It is based on the standard error of the mean.
>
> Uncertainty Limits - The interval resulting from the combination of the random errors and systematic error (bias).

Confidence limits on the mean and on individual values may both be used in situations in which a dependent variable (y) is estimated from one or more independent variables (x) by means of a regression equation. The three limits defined are associated with a confidence level of 95%.

3.1 Data Reduction

The thermal conductivities, k, were calculated from the data using the formula

$$k = \frac{d(\dot{Q}x/A)}{dE} \cdot \frac{dE}{dT} \tag{1}$$

where

$\dot{Q}$ = the heat flux (watts)

x = the distance of the thermocouple from the cold source (cm)

A = the cross-sectional area (cm^2)

E = the thermocouple voltage (μV)

dE/dT = the thermoelectric power of the thermocouple at the given voltage, E, and for the given reference temperature, T

In the first phase of the analysis, corrections were made to the output thermocouple voltages. These corrections were necessary because of changes in barometric pressure, reference-ring temperature, etc. A preliminary plot of $\dot{Q}x/A$ as a function of E was made to check for any gross errors that might have been made in recording the data or in the calculations.

Three thermocouple voltages, one from each thermocouple on the specimen were obtained from each run, a run being one setting of $\dot{Q}$. A curve generated from the quadratic equation

$$\dot{Q}x_i/A = B + CE_i + DE_i^2 \qquad i = 1, 2, 3 \tag{2}$$

was passed through the three points from each run,

$$(E_1, \dot{Q}x_1/A), (E_2, \dot{Q}x_2/A), \text{ and } (E_3, \dot{Q}x_3/A),$$

to give the values for B, C, and D. The derivative of Equation 2 was then used in Equation 1 to calculate the thermal conductivity

for each E_i. Conversion of the E_i to temperature then results in three data points,

$$(T_1, k_1), (T_2, k_2), \text{ and } (T_3, k_3),$$

for each run, where T_1 is the temperature at T/C 1 (cold end of the specimen), T_2 is the temperature at T/C 2, and T_3 is the temperature at T/C 3 (hot end of the specimen).

The temperature-thermal conductivity data from n runs were combined to give N = 3n data points. These data were processed by use of an IBM 360 computer to give the reported results. The computer program was used to fit the k vs T data [also ρ (resistivity) vs T and ρ vs Φ (neutron fluence) data] by the method of least squares to first-, second-, third-, and fourth-order polynomials of the form

$$k_{ij} = C_1 + C_2T_{ij} + C_3T_{ij}^2 + C_4T_{ij}^3 + C_5T_{ij}^4 \qquad \begin{matrix} i = 1, 2, 3 \\ j = 1, n \end{matrix} \qquad (3)$$

where

C's = coefficients to be estimated from the data

T_{ij} = ith temperature for the jth run corresponding to the recorded E_{ij} reading

k_{ij} = estimated thermal conductivity at the ith temperature for the jth run

n = number of runs

Figure 3-1 is a generic plot of some $\dot{Q}x/A$ vs E data and Figure 3-2 is the corresponding k vs T plot obtained by the analysis method (individual-run basis described above). As can be

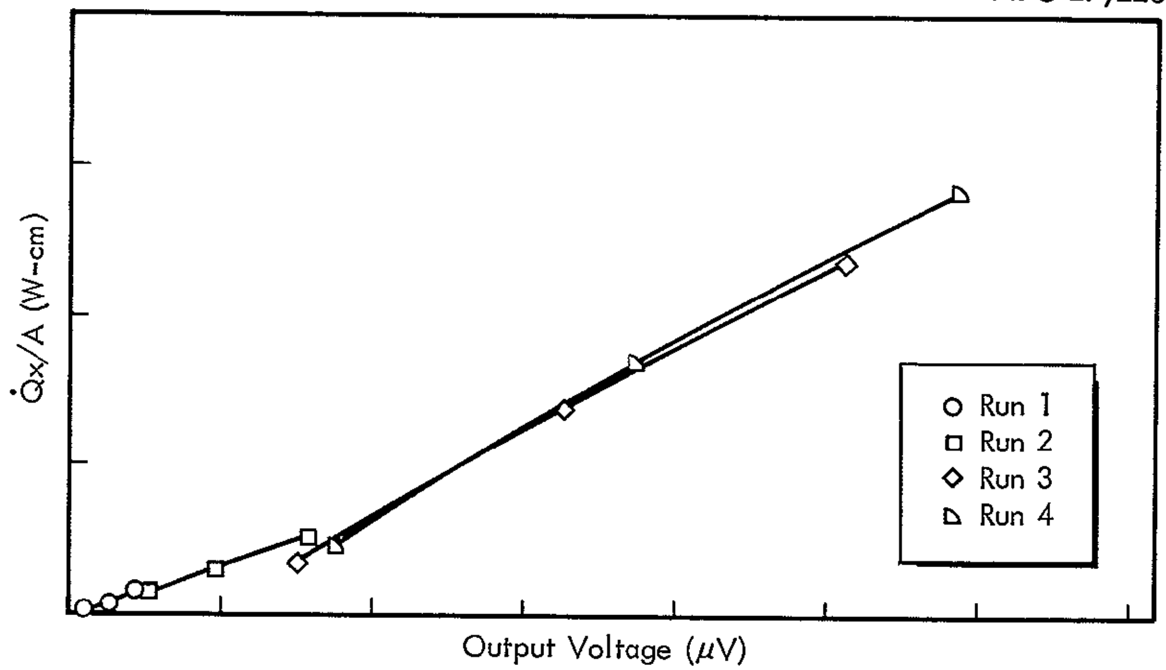

Figure 3-1 A Generic Plot of $\dot{Q}x/A$ as a Function of Thermocouple Output Voltage

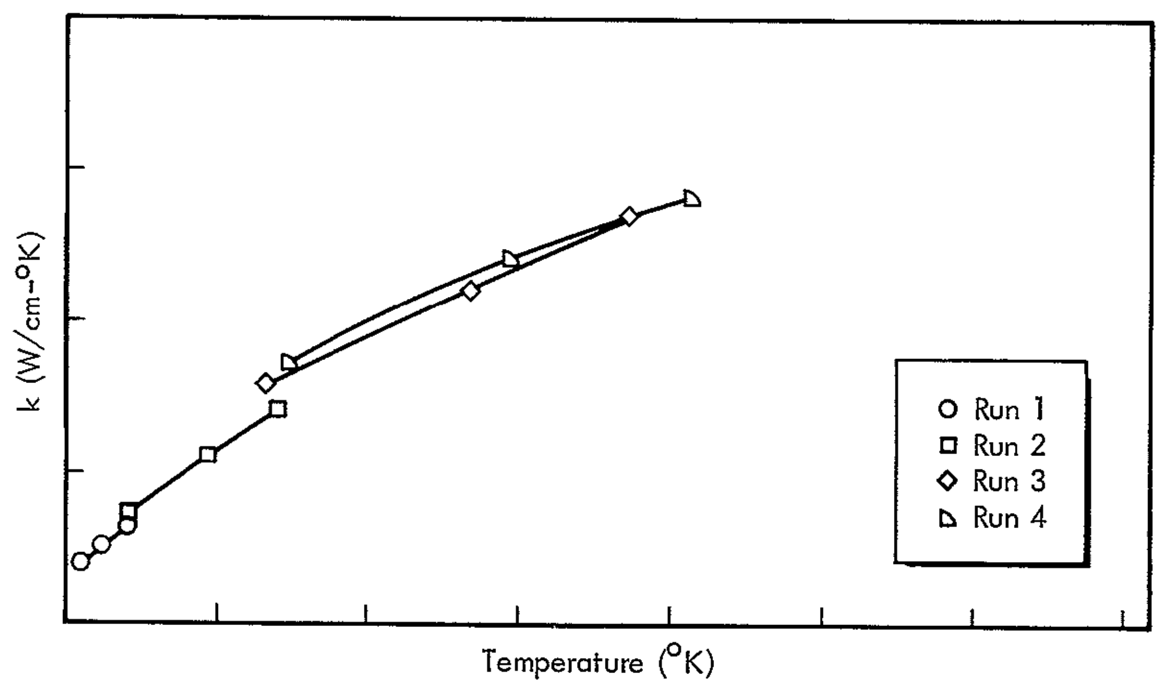

Figure 3-2 Thermal Conductivity as a Function of Temperature for Individual Runs

seen in Figure 3-2, a k-vs-T curve can be constructed for a given run over the range of temperatures covered in that run. A least-squares fit of the combined-runs data was used to estimate a mean curve to represent the combined data. Statistical limits, along with estimates of the statistical parameters for calculating the various limits, are presented in graphical form and/or in the data tables.

The change in thermal conductivity, Δk, from preirradiation to postirradiation was determined from like runs in which the three temperatures were nearly the same. Since the temperatures were not exactly the same, Equations 1 and 2 were used to calculate a preirradiation k and a postirradiation k, k(pre) and k (post), respectively, for the same temperature. For example, if k(pre) = 2.21 at $T_1 = 81.3^oK$ and k(post) = 1.98 at $T_1 = 82.6^oK$, Equations 1 and 2 were used to calculate a k(pre) at 82.6^oK. Thus, $\Delta k_1 = 1.98 - k(pre)$ at 82.6^oK. Δk_2 and Δk_3 were treated similarily. The Δk_{ij} data were processed the same as the k_{ij} data with the computer program.

Thermal conductivities and electrical resistivities vs temperature for the various specimens were calculated from the fitted ploynomials selected to represent the mean curve. This was done for several temperatures starting at 80^oK and increasing in steps of ΔT^oK. Additional calculations made from these fitted data at several temperatures were:

1. Change in electrical resistivity from preirradiation to postirradiation,

$$\Delta\rho = \rho(\text{post}) - \rho(\text{pre}), \tag{4}$$

for tests R104 and R201.

2. "Effective" Lorenz ratio,

$$L_{eff} = k\rho/T, \tag{5}$$

for preirradiation, postirradiation, and postirradiation anneal for test R104.

3. Thermal conductivities using the effective Lorenz ratio,

$$k(\text{post}) = L_{eff}(\text{pre})T/\rho\,(\text{post}) \tag{6}$$

for test R104.

4. Thermal conductivities using the Sommerfeld value (L_S),

$$k_S = L_S T/\rho, \tag{7}$$

for preirradiation and postirradiatin for test R201 and postirradiation for test R104.

3.2 Statistical Analysis

Statistical methods have been used to aid in the analysis and presentation of the results. As in other situations in which mathematics is used as a tool, assumptions are required. The statistical limits applied to the data are valid only within the framework of the assumed structure of the variation present in the observations, i.e., the errors are assumed to be normally and independently distributed about the fitted curves. Mild departures from normality, however, have little effect on the

probabilities associated with the t-values used in the confidence limits.

The main limitation on the conclusions drawn from the data is the population to which the conclusions apply. A reliable estimate of the experimental error associated with the generalization of these results to the whole population of batches of a given material for a given temperature or neutron fluence cannot be made from the data. The conclusions apply to the specific specimens used in this experiment.

3.2.1 Variance of an Average Value and of a Single Estimated Value

For this analysis it has been assumed that the observations and parameters are related as expressed by Equation 3. In matrix notation, the data array appears as

$$Y = XC + e$$

where

$$Y = \begin{bmatrix} k_1 \\ \cdot \\ \cdot \\ \cdot \\ k_N \end{bmatrix}, \qquad C = \begin{bmatrix} C_1 \\ \cdot \\ \cdot \\ \cdot \\ C_{m+1} \end{bmatrix}, \qquad e = \begin{bmatrix} e_1 \\ \cdot \\ \cdot \\ \cdot \\ e_N \end{bmatrix}$$

$N = 3n$ = total number of data points, $m = 1, 4$ (order of fit), and, for an order of fit $m = 4$,

$$X = \begin{bmatrix} 1 & T_1 & T_1^2 & T_1^3 & T_1^4 \\ 1 & \cdot & \cdot & & \\ \cdot & \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & & \\ 1 & T_N & \cdot & \cdot & T_N^4 \end{bmatrix}$$

Here, Y is either thermal conductivity, k_i, or electrical resistivity, ρ_i, and X is either temperature, T_i, or neutron fluence, Φ_i, depending upon the data being considered for analysis. The term e represents some residual error - the amount of Y not accounted for by the regression curve of Y on X. The C's are estimated by the method of least squares by minimizing $e^T e$ (T superscript denotes transpose). The e's are assumed to have zero mean, constant variance, and to be uncorrelated.

The variance-convariance matrix of the estimates of the C's for a fixed set of X's is given by

$$\left[X^T X\right]^{-1} \sigma_e^2$$

where -1 denotes inverse and σ_e^2 is the error variance. A term s_e^2 is defined as the average sums-of-squares of deviations from the fitted curve and is an estimate of σ_e^2; it was calculated for each order of fit, m, and was used in conjunction with engineering judgment in selecting the degree of the polynomial to represent the data. In other words, the data were fitted to polynomials of first, second, third, and fourth degree, and an s_e^2 was computed for each; the order of fit was then selected for which there was little or no reduction in s_e^2 for a higher order of fit. If there was a small difference in the s_e^2, the lower order of fit was generally chosen, or the order of fit was chosen to give a consistent set of polynomials for the preirradiation, postirradiation, and postirradiation anneal data.

The row matrix of the coefficients of the linear function (Equation 3) of the C's is

$$G = (1 \ T \ T^2 \ T^3 \ T^4)$$

The variance of an average k, $\overline{k}$, for a fixed set of temperatures is given by

$$\mathrm{Var}(\overline{k}) = \left(G\left[X^T X\right]^{-1} G^T\right)\sigma_e^2 \tag{8}$$

The variance of a single estimated value of k, k', for a fixed set of temperatures is given by

$$\begin{aligned}\mathrm{Var}(k') &= \left(G\left[X^T X\right]^{-1} G^T + 1\right)\sigma_e^2 \\ &= \mathrm{Var}(\overline{k}) + \sigma_e^2 \end{aligned} \tag{9}$$

Substituting s_e^2 for σ_e^2 in Equations 8 and 9 gives the estimated variances, S^2. The resulting working equations are. for the thermal conductivity data,

$$\mathrm{Var}(\overline{k}) = S_{\overline{k}}^2 \tag{10}$$

$$\mathrm{Var}(k') = S_{k'}^2 \tag{11}$$

and, for the resistivity data,

$$\mathrm{Var}(\overline{\rho}) = S_{\overline{\rho}}^2 \tag{12}$$

$$\mathrm{Var}(\rho') = S_{\rho'}^2 \tag{13}$$

3.2.2 Variance of the Calculated Data

The variance of $\Delta\rho = \rho(\text{post}) - \rho(\text{pre})$ was estimated from

$$S_{\Delta\rho}^2 = S_{\rho(\text{post})}^2 + S_{\rho(\text{pre})}^2$$

The general approach for determining the variances of the cal-

culated data (L_{eff}, k_S, etc.) from the k and ρ data was:

Let

$$Y = XV/Z \qquad (14)$$

where Y is the dependent variable and X, V, and Z are either independent variables or constants depending upon the Y being calculated.

Assume that X, V, and Z (when used as variables) are independent, and that the function Y = XV/Z varies slowly in the region where the values of the independent variables occur such that it can be represented by the linear terms of its Taylor-series expansion. The variance of Y, Var(Y), is then approximated by

$$\mathrm{Var}(Y) \cong \left(\frac{X}{Z}\right)^2 \mathrm{Var}(V) + \left(\frac{V}{Z}\right)^2 \mathrm{Var}(X) + \left(-\frac{XV}{Z^2}\right)^2 \mathrm{Var}(Z) \qquad (15)$$

As an example, consider the calculation of the effective Lorenz ratio from

$$L_{eff} = k\rho/T \qquad (14\text{-a})$$

Substituting $L_{eff} = Y$, $k = X$, $\rho = V$, and $T = Z$ = constant $[\mathrm{Var}(Z) = 0]$ into Equation 15 gives

$$\mathrm{Var}(L_{eff}) \cong \left(\frac{k}{T}\right)^2 \mathrm{Var}(\rho) + \left(\frac{\rho}{T}\right)^2 \mathrm{Var}(k) \qquad (15\text{-a})$$

The substitution of the estimated values for ρ, k, Var(ρ), and Var(k) at the selected temperature into Equations 14-a and 15-a gives L_{eff} and Var(L_{eff}), respectively. The other quantities

and the variances thereof are similarly obtained by substitution of the proper estimates into Equations 14 and 15.

3.2.3 Confidence Limits

The estimated value of Y' for a given X, say X', is

$$Y' = \sum_{i=1}^{m+1} C_i X'^{(i-1)} \tag{16}$$

where

$Y' = k$ or ρ

$X' = T$ or Φ

C_i's = estimates from the fitted curve

m = order of fit

Two sets of confidence limits were calculated for the data:

1. The confidence limits for the mean of all Y' (expected value of Y') which might occur for a given value of X = X'.

2. The confidence limits for an individual, or single, estimated Y' for a given value of X = X'.

It has been assumed that the e's (deviations from the fitted curve) are normally distributed. Using the estimated variances for the various results, the following confidence limits were calculated:

$$Y' \pm t_\alpha S(\text{mean})$$

$$Y' + t_\alpha S(\text{individual})$$

where

$$S(\text{mean}) = \sqrt{S^2_{\bar{k}}} \text{ or } \sqrt{S^2_{\bar{\rho}}} \qquad (17)$$

$$S(\text{individual}) = \sqrt{S^2_{k'}} \text{ or } \sqrt{S^2_{\rho'}} \qquad (18)$$

t_α is a tabular t-value

For the confidence limits presented, $\alpha = 0.05$, which is a $100(1-\alpha)\% = 95\%$ confidence limit.

For both sets of confidence limits, Y' was estimated from Equation 16. The second confidence limit is necessarily wider because the variability of the individual Y's is also considered, e.g.,

$$S_{k'} = \sqrt{S^2_{\bar{k}} + s^2_e}$$

Similar procedures were used to obtain confidence limits for the calculated results. The estimates obtained from Equation 16 for k and ρ were used in Equation 14 to give an analagous Y' value at the selected X'. The variances were calculated from Equation 15 by substituting the estimates for the Var(k), Var(ρ), etc. for the corresponding Var(X), Var(V), etc. However, $s^2_e(k) \neq s^2_e(\rho)$, and when these estimates were combined in Equation 15 to estimate the variance for the function Y = XV/Z, it was necessary to use a different t_α for calculating confidence limits for the function. Equation 15 can be used to combine the variances, but a t-value based on the combined degrees of freedom (d.f.) cannot be used; thus, the following approximate t-value, t'_α, was used:

$$t'_\alpha = \frac{\sum_{i=1}^{r} w_i t_{\alpha_i}}{\sum_{i=1}^{r} w_i} \qquad r = 2 \text{ or } 3 \qquad (19)$$

where

$w_i = s_{e_i}^2/N_i$

t_{α_i} = tabular t_α corresponding to the d.f. associated with the estimate of $s_{e_i}^2$

3.3 Systematic Bias

The systematic bias is any fixed deviation that is inherent in each measurement of thermal conductivity in a particular sequence of measurements (Ref. 4). The systematic bias in this experiment results from three factors (Ref. 5):

1. Interface resistance between the specimen and the test-cell lid
2. Transient drift of the specimen and its associated components
3. Thermal leakage

The thermal interface resistance causes a temperature differential between the end of the specimen and the test-cell lid, which in turn causes the end of the specimen and the temperature readings at the three thermocouple locations to be higher than they would be if no interface resistance were present. If no interface resistance were present, the extrapolated temperature-distribution plots (temperature vs distance along the specimen)

for all data runs should, theoretically, intersect at the bath reference temperature, i.e., 77.4°K at x = 0. The extrapolated curves for all materials except the WANL beryllium intercept the temperature axis at a temperature greater than 77.4°K at x = 0. However, data reduction on an individual-run basis reduced the effect of the interface resistance, so that there was little or no effect on the final results.

Transient drift is defined as an apparent heat leak due to a change of system enthalpy during transient conditions because of the thermal capacitance of the specimen and associated components. Although all of the specimens except the titanium were sized to keep the error associated with transient drift to no more than 1% of the specimen heater power, it is felt that the transient drift of the specimen and its associated hardware is a significant cause for data shifts. The diameter of the titanium specimen was limited to 0.625 in. so as to maintain at least two specimen diameters between the end thermocouples and parts of the test units which would perturbate the heat flow in order to insure unidirectional heat flow at all points of temperature measurements.

Thermal equilibrium, defined as existing when the outputs of all thermocouples inside the test apparatus remain constant to within $\pm$ 1μV for a minimum of 1 hour, is difficult and time consuming to achieve. The following examples are cited:

1. If a data-run temperature is being approached from a lower temperature and the thermocouple outputs are not cycling about an apparent mean, more power than is necessary to achieve the specimen temperature differential must be supplied by the specimen heater in order to bring the heater core and thermocouple clamps, as well as the specimen, to thermal equilibrium. This results in a positive Q-shift when going to a higher ΔT run.

2. If the data-run temperature is being approached from a higher temperature, less power is required to achieve the required temperature differential because of the stored energy in the heater core, specimen, and thermocouple clamps. This results in a negative Q-shift when going to a lower ΔT run.

It is felt that transient drift is a possible cause of data shifts for the WANL beryllium and for the NBS beryllium and aluminum in the low-temperature runs. None of the shift for WANL beryllium can be attributed to interface resistance, but the data are still shifted on the plot of $\dot{Q}x/A$ vs E.

Thermal leakage is defined as the difference between heat transmitted by the specimen heater and the heat being conducted through any incremental length of the specimen. Thermal leakage is a significant cause for data shifts at higher temperatures. It resulted in a positive Q-shift for all materials except the NBS beryllium. It is suspected that the NBS beryllium received a significant amount of leakage heat from the shield heater.

The graphite specimen is believed to have had more thermal leakage than was predicted in the uncertainty analysis (Ref. 6)

because the shield was constructed of two dissimilar graphite segments (PO-3 and ATJ) and had a backing cylinder of stainless steel which provided an additional parallel heat path. Reference 6 contains predictions for the thermal leakage under the assumptions of (1) no contact between shield laminations and (2) intimate contact between shield laminations. However, it was assumed in the analysis that the graphite portion of the shell was of uniform composition. The ATJ graphite has approximately twice the thermal conductivity of PO-3 graphite at 77°K, but the conductivities for the two materials converge at approximately 600°K.

Very large thermal leakages are predicted for the titanium specimen in Reference 6 because of the dissimilar temperature distributions in the specimen and shield. This was caused by the titanium shell being too thin (0.020 in. thick), resulting in insufficient thermal conductance. At a specimen temperature differential of 350°K, only 57% of the shield-heater power was conducted along the shell with the balance being transferred to the heat sink through direct thermal radiation and multiple reflections. Consequently, the temperature distribution in the shell was influenced almost as much by thermal radiation as by conduction.

As stated previously, interface resistance is not considered a problem when the data are treated on an individual-

run basis. The errors resulting from the two remaining factors contributing to the systematic bias, transient drift and thermal leakage, are shown graphically in Figures 3-3, 3-4, and 3-5. These curves, taken from Reference 6, were used in computing the systematic bias of the data presented in this report.

The percent specimen heater power at T/C 3 for each ΔT or $\dot{Q}$ setting was determined for each specimen from Figure 3-3, 3-4, or 3-5. The systematic bias was calculated from

$$\text{Systematic Bias} = (\%\ \text{heater power})(k_{T/C3})$$

where $k_{T/C3}$ is the thermal conductivity measured at T/C 3 for each data run.

For example, the temperature at T/C 3 for titanium Preirradiation Run 1 was 97.4°K (Table F-22). From Figure 3-4 the percent specimen heater power is 10.4%; this multiplied by an arbitrary uncertainty factor of 2 gives a total of 20.8%. From Table F-22, $k_{T/C3}$ for Run 1 is 0.05184 watts/cm-°K. The systematic bias is then

$$\text{Systematic Bias} = (0.208)(0.05184) = 0.01078 \text{ watts/cm-}^{\circ}\text{K}$$

3.4 Uncertainty Limits

The uncertainty limits as used in this report are defined as those limits which are based on a composite error containing both the random errors and the systematic bias. Confidence limits on an individual value and on the mean are normally used when the variability, or error, is random. However, in some

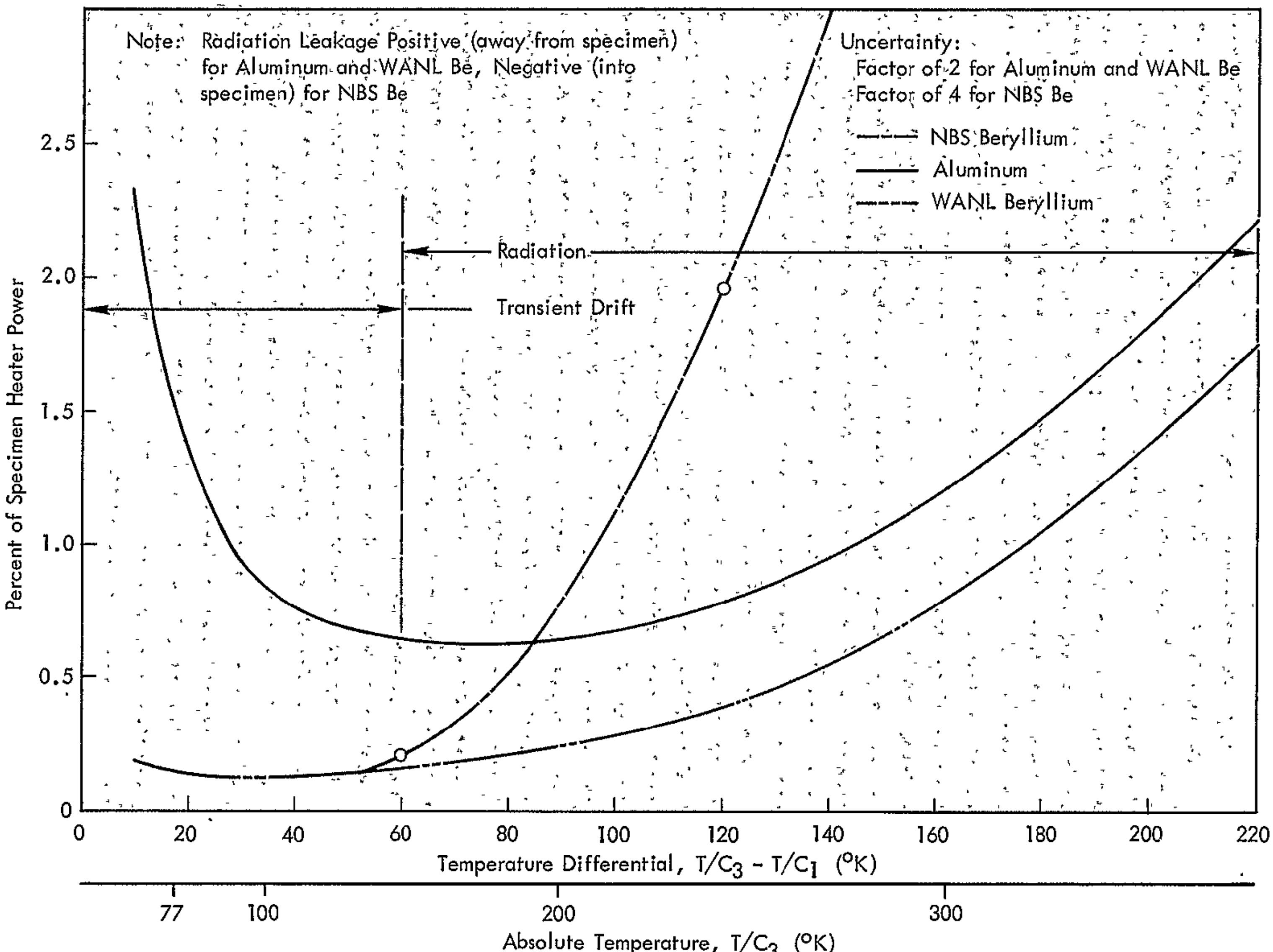

Figure 3-3 Thermal Leakage of Aluminum and Beryllium

NPC 27,228

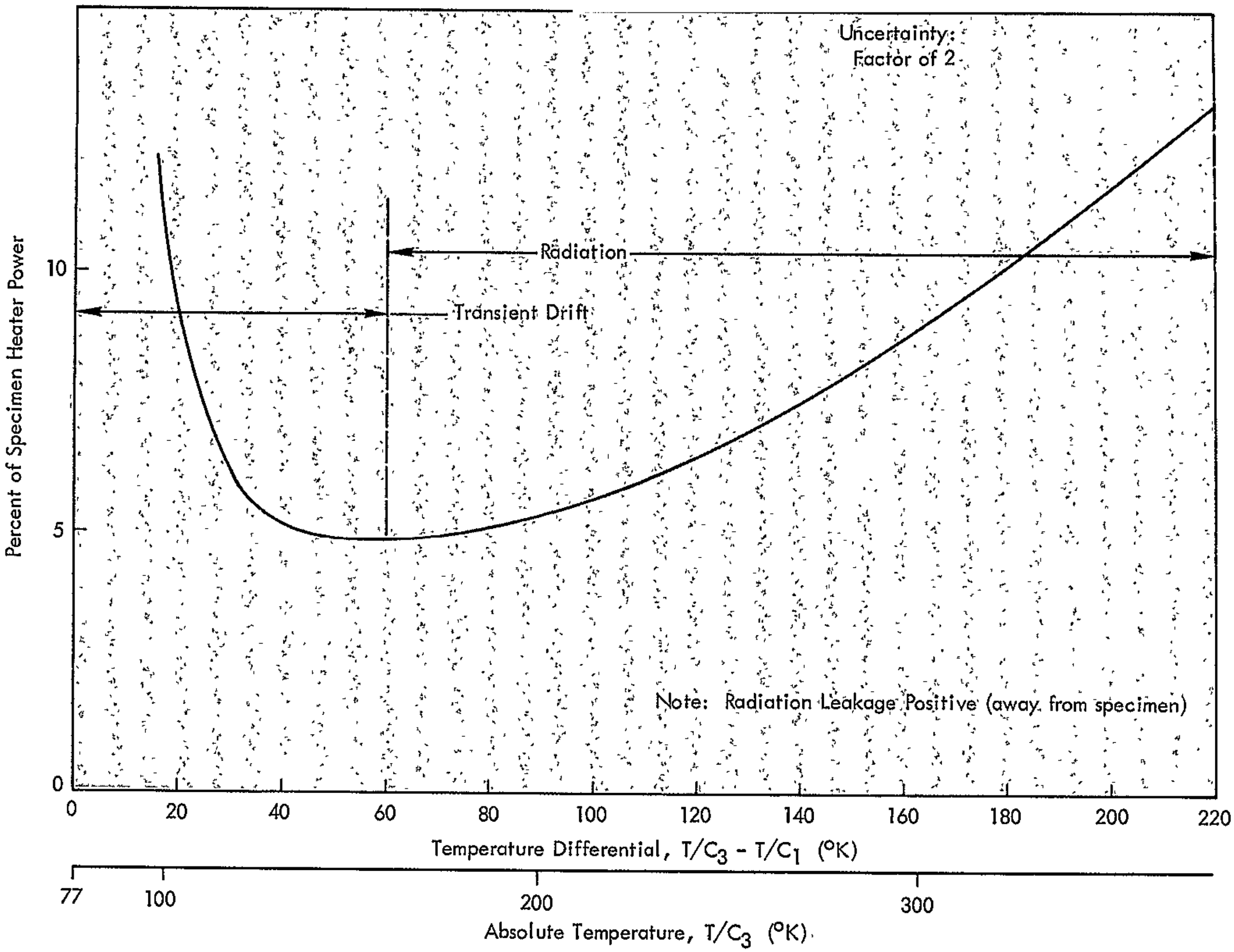

Figure 3-4 Thermal Leakage of Titanium

NPC 27,229

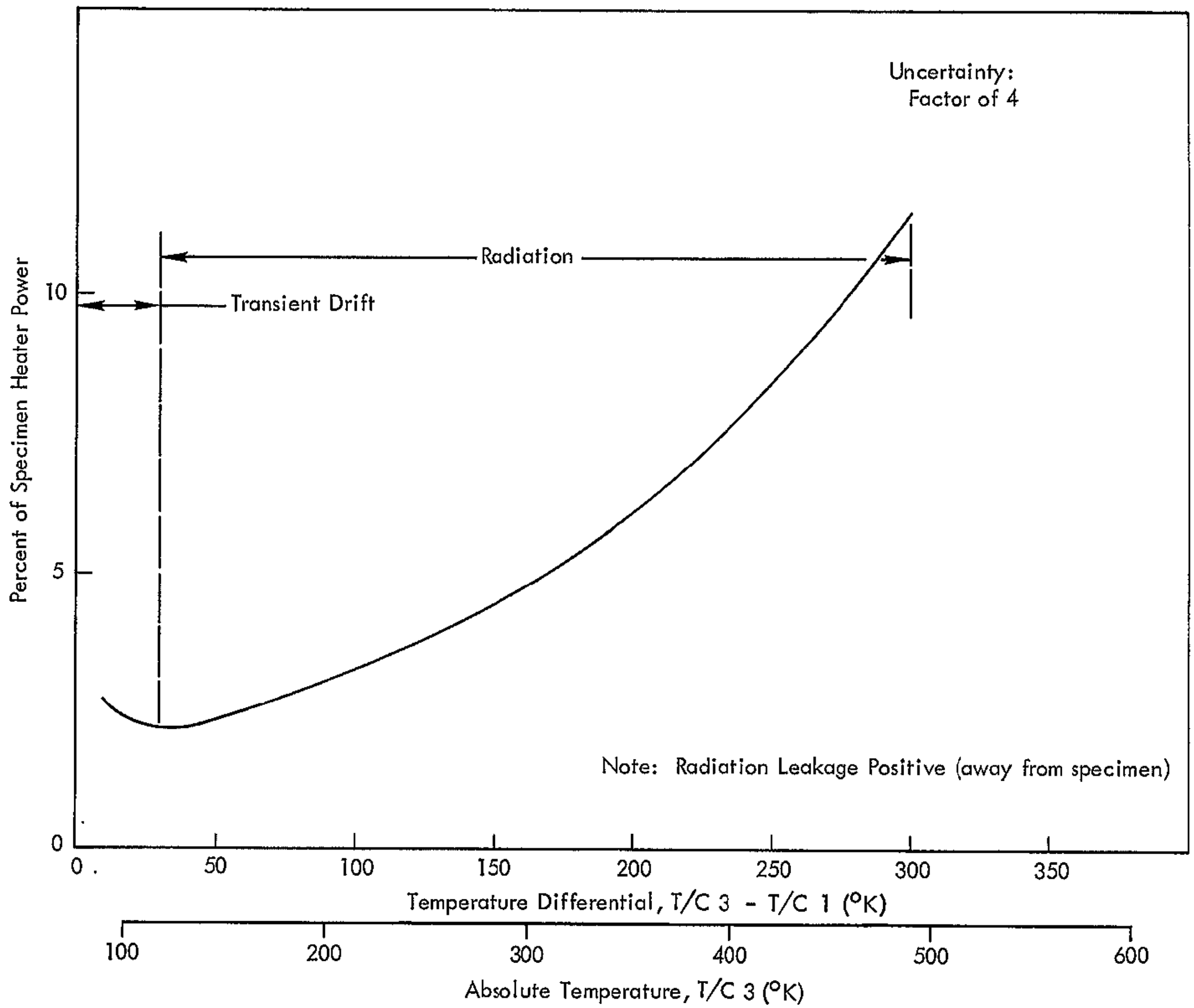

Figure 3-5 Thermal Leakage of PO-3 Graphite with Perfect Contact Between Shell and Backing

NPC 27,230

cases indentifiable systematic biases may be present in addition to the random error. The two types of errors may then be combined to generate a composite error, or overall uncertainty, for the experimental system.

There are several ways to compute uncertainty limits. No single form of expression for these limits is universally satisfactory. The choice will depend on the importance in relation to the intended use of the reported value. Common methods of computing the uncertainty limits are by taking the root mean square of the systematic bias and the confidence limit on the individual values or the mean, or by the summation of the systematic bias and the confidence limit on the individual values or the mean (Ref. 7). In this report the uncertainty limits for the thermal conductivity data are overall limits of error based on the summation of the 95% confidence limits on the individual values and the systematic bias; this method results in wider limits than would the use of any of the other three methods indicated above.

For an example, the systematic bias calculated previously for the titanium Preirradiation Run 1 was 0.01078 watt/cm-^{o}k at 97.4^{o}K. As noted in Figure 3-4, this bias is assumed to be positive (heat flow away from the specimen). Therefore, the upper uncertainty limit will be the same as the upper 95% confidence limit on individuals (0.05480 watt/cm-^{o}K) and the lower

uncertainty limit will be the lower 95% confidence limit minus the systematic bias (0.046 - 0.01078 = 0.03522).

3.5 Thermal Conductivity Test

Tables E-1 through E-15 of Appendix E present the raw experimental data recorded at thermal equilibrium for each specified temperature gradient across the specimen. Three data tables are given for each specimen - one containing the preirradiation data, one containing the postirradiation data, and one containing the postirradiation-anneal data. Most of the data recorded, but not given in the tables, consist of those measurements taken on each specimen at specified increments of time to determine what corrections, if any, should be made to the shield-heater power to bring the specimen and shield into thermal equilibrium. Consequently, the data shown in Tables E-1 through E-15 present the outcome of numerous data cycles during which thermal equilibrium was being approached and finally achieved. An explanation of the data appearing in these tables is presented at the beginning of Appendix E.

The thermal conductivities at the various temperatures computed from the data in Appendix E are tabulated in Tables F-1 through F-35 of Appendix F. In addition to the thermal conductivity (given as "Input Data") as calculated by the procedure described in Section 3.1, curve fits have been performed and the confidence limits on the individual and mean values have been computed and tabulated in these tables. The coefficients for

the equation expressing k as a function of temperature are given along with other related data. Again, the data are given separately for the preirradiation, postirradiation, and postirradiation-anneal runs. An additional table for each material gives the same type of information for the change in thermal conductivity (Δk) from preirradiation to postirradiation.

The test results are presented graphically in Figures 3-6 through 3-20. The data from the Appendix F tables are shown as sets of plots; these contain the individual data points, the mean curves computed by the least-squares fit, the 95% confidence limits on the individual and mean values, and the 95% uncertainty limits. Where no 95% uncertainty limits are shown, they are the same as the 95% confidence limits on the individual. The equation for the mean curve is shown on each plot.

For each material, two groups of plots are given: the first is based on calculations using only selected data runs, i.e., the low-ΔT data runs up to a point where excessive shifts in the data appear, and the second group is based on the data from all runs. The Δk plots are based on all data runs.

3.5.1 Discussion of Results

3.5.1.1 Aluminum

Figure 3-6 shows plots of the thermal conductivity vs temperature for selected data runs for preirradiation, postirradiation, and postirradiation-anneal and the change in thermal conductivity due to irradiation. A total of ten data runs were

made on the aluminum specimen over the temperature range of 80° to 360°K; only the first four of these were used to compute the k-vs-T curves in Figure 3-6 because plots of $\dot{Q}x/A$ vs E and specimen power vs shield power indicate that thermal leakage was beginning to become appreciable after Run 4 (T > 180°K). Figure 3-7 shows plots based on all of the data runs. Figure 3-7(d) is a comparison of the mean curves of the preirradiation data with data from an aluminum specimen run by NBS.

In Section 3.3 it was indicated that transient drift was a possible cause of data shifts in the low-temperature runs. These shifts could be positive or negative, depending on whether the temperature of the data run was being approached from a higher or lower temperature. In the aluminum preirradiation test, two high-temperature runs (Runs 22 and 23) were made before a low-temperature run, as shown in Table E-1. This was done to check the upper limitations of the apparatus. In the postirradiation-anneal test, all temperature runs were made in sequence (see Table E-3), i.e., the low-temperature runs were made first. The difference in the preirradiation and postirradiation-anneal data in Figure 3-7 is less than 0.6% from 80°K to 360°K. If the transient drift error, as shown in Figure 3-3, is approximately 2% and the bias is such as described in Section 3.3, then the difference in the pre- and postirradiation-anneal data, at low temperatures, should be on the order of several

percent. The experimental data tends to show that the transient drift error for the aluminum specimen is negligible. Even though this is indicated, the uncertainty limits for aluminum are calculated as described in Section 3.4.

The preirradiation values of k determined from this test ranged from 0.854 watt/cm-^{o}K at 80^{o}K to 1.231 watts/cm-^{o}K at 180^{o}K for the selected data runs. The postirradiation data ranged from 0.815 watt/cm-^{o}K at 80^{o}K to 1.230 watts/cm-^{o}K at 180^{o}K. The preirradiation values determined from all data runs ranged from 0.861 watt/cm-^{o}K at 80^{o}K to 1.304 watts/cm-^{o}K at 180^{o}K to 1.739 watts/cm-^{o}K at 360^{o}K. The postirradiation data ranged from 0.812 watt/cm-^{o}K at 80^{o}K to 1.299 watts/cm-^{o}K at 180^{o}K to 1.796 watts/cm-^{o}K at 360^{o}K.

The maximum percent change in k from preirradiation to postirradiation was -5% at 80^{o}K, and this was annealed at 192^{o}K.

Figure 3-7(d) is a comparison of the GDFWD preirradiation curves and data obtained by NBS (Ref. 8) on a different specimen. Even though the difference may be due in part to the variability of aluminum, these data give added confidence to the data obtained in this experiment.

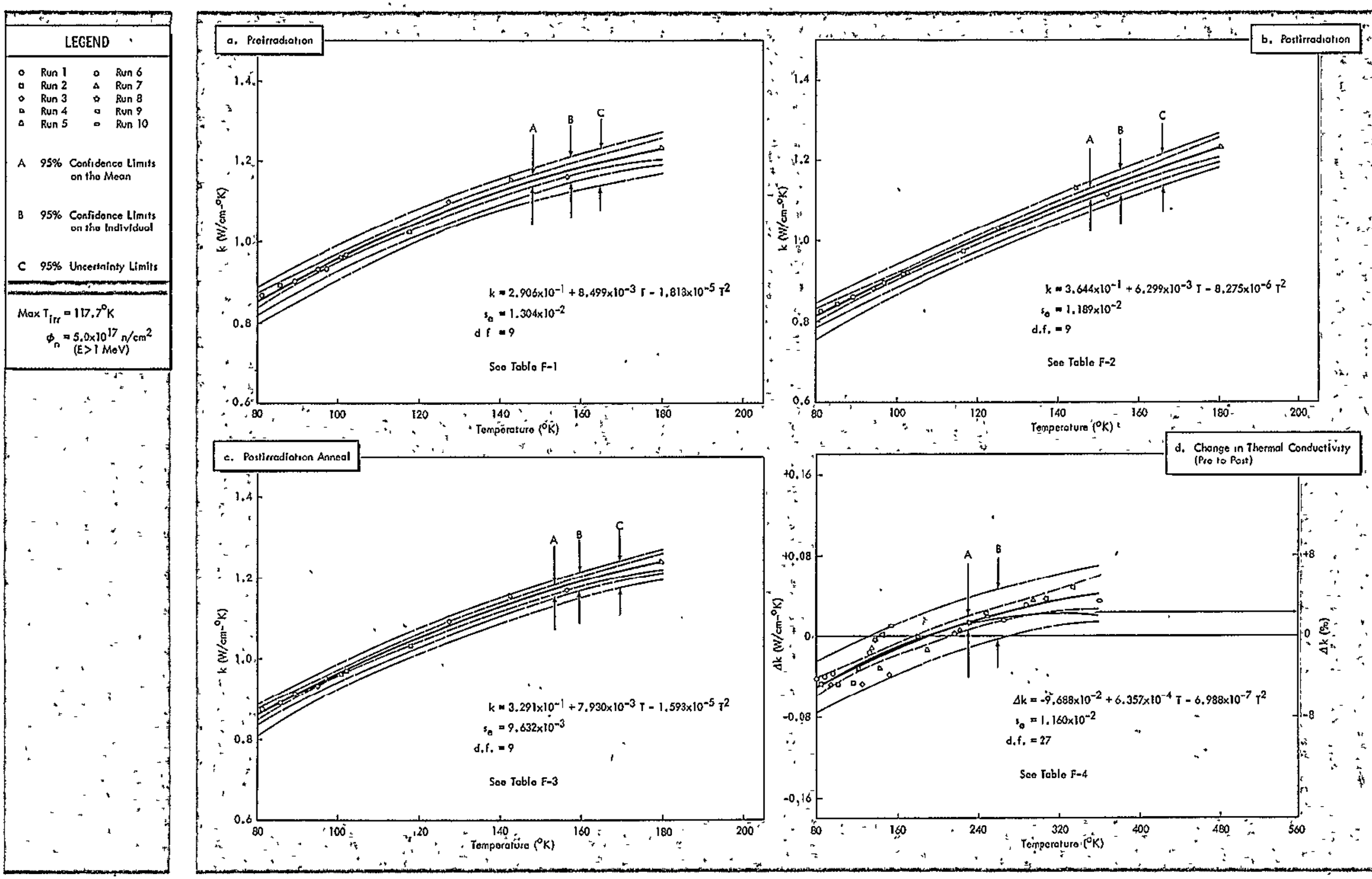

Figure 3-6 Thermal Conductivity of Aluminum as a Function of Temperature for Selected Data Runs

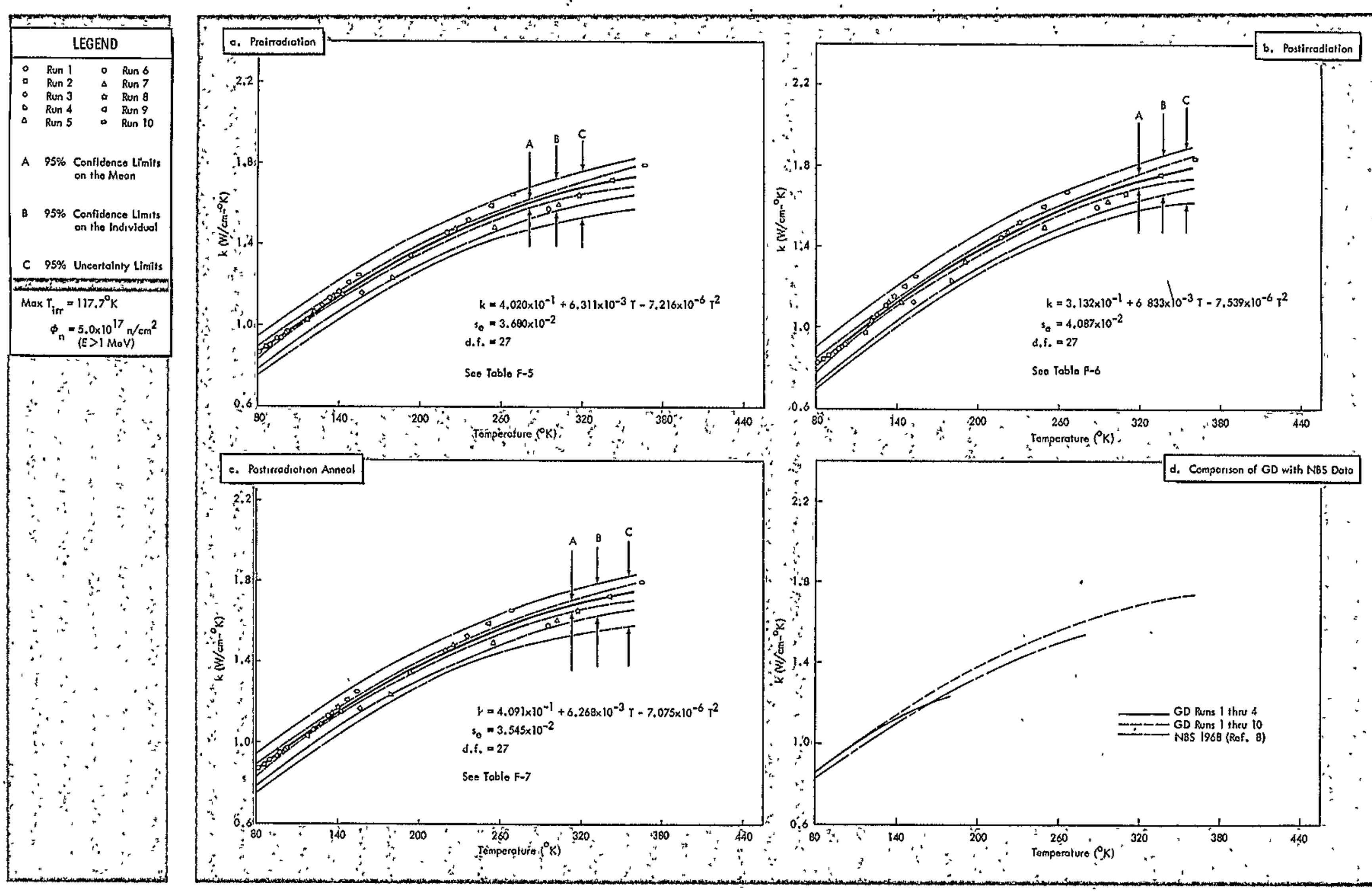

Figure 3-7 Thermal Conductivity of Aluminum as a Function of Temperature for All Data Runs

3.5.1.2 NBS Beryllium

A total of six data runs were made in the preirradiation test, four data runs in the postirradiation test, and five data runs in the postirradiation-anneal test. Figure 3-8 is plots of thermal conductivity vs temperature for selected data runs for preirradiation (Runs 1-4), postirradiation (Runs 1-4), and postirradiation-anneal (Runs 1-4), and the change in thermal conductivity due to irradiation. Figure 3-9 is plots of thermal conductivity vs temperature for all data runs and a comparison of the preirradiation data with NBS data on the same specimen.

The disagreement between the GDFWD preirradiation data for the NBS beryllium specimen and the measured data of Powell (Ref. 1) and Hust (Ref. 2) cannot be fully explained. The prototype data (Prototypes 1 and 2) agree with the two NBS measurements (Powell and Hust) about as well as the two NBS measurements agree with each other (see Fig. 2-24). However, the preirradiation and postirradiation-anneal data shown in Figures 3-8 and 3-9 match the Prototype 2 data at temperatures from 80°K to 120°K, but diverge considerably at higher temperatures. Figure 3-10, a plot of the shield-heater power vs thermocouple emf at Thermocouple 3, shows that the NBS beryllium shield, which is the same one used for Prototype 1 and identical to the shields used in the Prototype 2 and WANL beryllium units, required considerably more power than did the others for the same temperature

or thermocouple emf. This would indicate the possibility of a poor thermal contact between the heater and shield. This would cause the shield heater to operate at a considerably higher temperature than it would with good contact. The specimen gets a view of the shield heater so that it is possible for heat to be transferred from the shield heater to the specimen by thermal radiation. This would cause the measured thermal conductivity to appear lower since it would not require as much power from the specimen heater to obtain the desired specimen temperature differential. Unfortunately, the temperature of the shield-heater core was not measured, but it is possible to obtain a rough estimate of the shield-heater-core temperature for the preirradiation measurements based on the assumption that the difference in shield-heater power requirements between the prototype runs and preirradiation runs is caused by thermal contact resistance. It is then possible to compute a temperature differential across the interface between the shield and shield heater to obtain an estimate of the shield-heater-core temperature. A digital computer run was made using the steady-state thermal model for the NBS beryllium unit. It was found that the increase in heat radiated from the shield heater to the specimen induced a leakage of approximately 2% of specimen-heater power to the specimen at a specimen ΔT of $120^{\circ}K$. This is shown by the rather large data shifts in the preirradiation data between data Runs 4 and 5. This resulted in a calculated value of

k that was lower than the actual specimen k.

The preirradiation values from Runs 1 through 4 ranged from 2.165 watts/cm-^{o}K at 80^{o}K to a maximum of 2.570 watts/cm-^{o}K at 130^{o}K, then decreased to a minimum of 2.283 watts/cm-^{o}K at 180^{o}K. The preirradiation values from Runs 1 through 6 ranged from 2.179 watts/cm-^{o}K at 80^{o}K to a maximum of 2.520 watts/cm-^{o}K at 140^{o}K, then decreased to a minimum of 1.844 watts/cm-^{o}K at 220^{o}K. The postirradiation values (Runs 1 through 4) ranged from 1.180 watts/cm-^{o}K at 80^{o}K to 1.715 watts/cm-^{o}K at 180^{o}K. The maximum percent change in k from pre- to postirradiation decreased as the temperature of the specimen increased and was -25% at the maximum temperature (180^{o}K) at which k was determined for this experiment.

During the postirradiation data cycle, k data were taken on the specimen up to a temperature of 180^{o}K. The specimen was allowed to return to LN_2 temperatures and the data cycle repeated. Examination of the raw experimental data indicated that annealing, if any, was not detectable, that is, the data repeated to within the precision of measurement ($\approx$ 1%).

After the specimen was warmed to room temperature for approximately 60 hours, the thermal conductivity measurements were repeated. The postirradiation-anneal data indicated a maximum increase of + 3.5% in k with reference to the preirradiation value, which could be an indication that the material had under-

gone some permanent property change due to the environments imposed upon it in the accomplishment of the experiment. However, since this increase is less than the total uncertainty, definite statements concerning this trend would be suspect, and without further tests to verify this trend, none should be made.

In summary, it can be stated that the change in k of NBS beryllium resulting from the radiation exposure of this experiment was significant (45% at 80°K), and that the value of the thermal conductivity returned to approximately its preirradiation value after a room-temperature anneal.

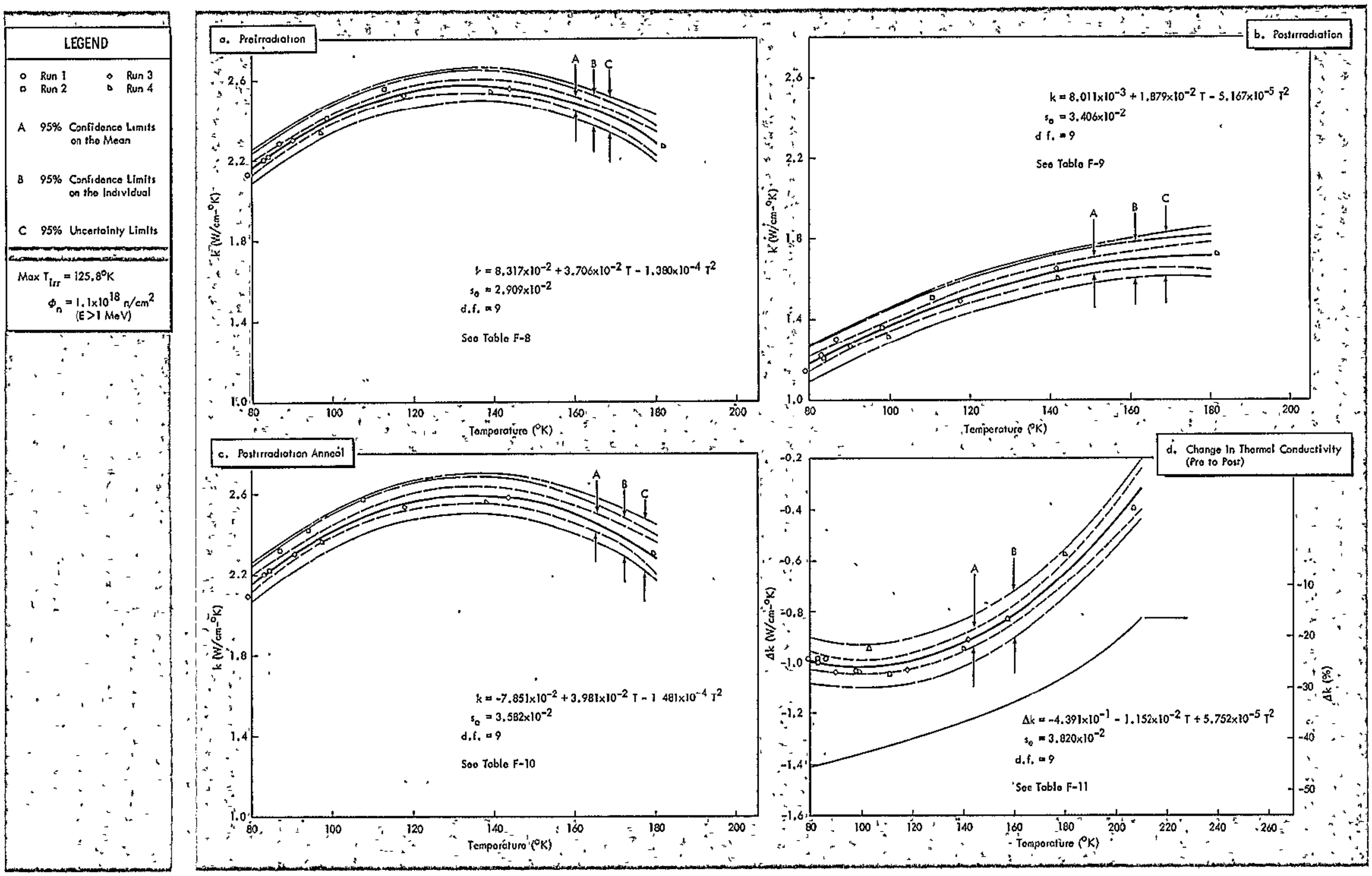

Figure 3-8 Thermal Conductivity of NBS Beryllium as a Function of Temperature for Selected Data Runs

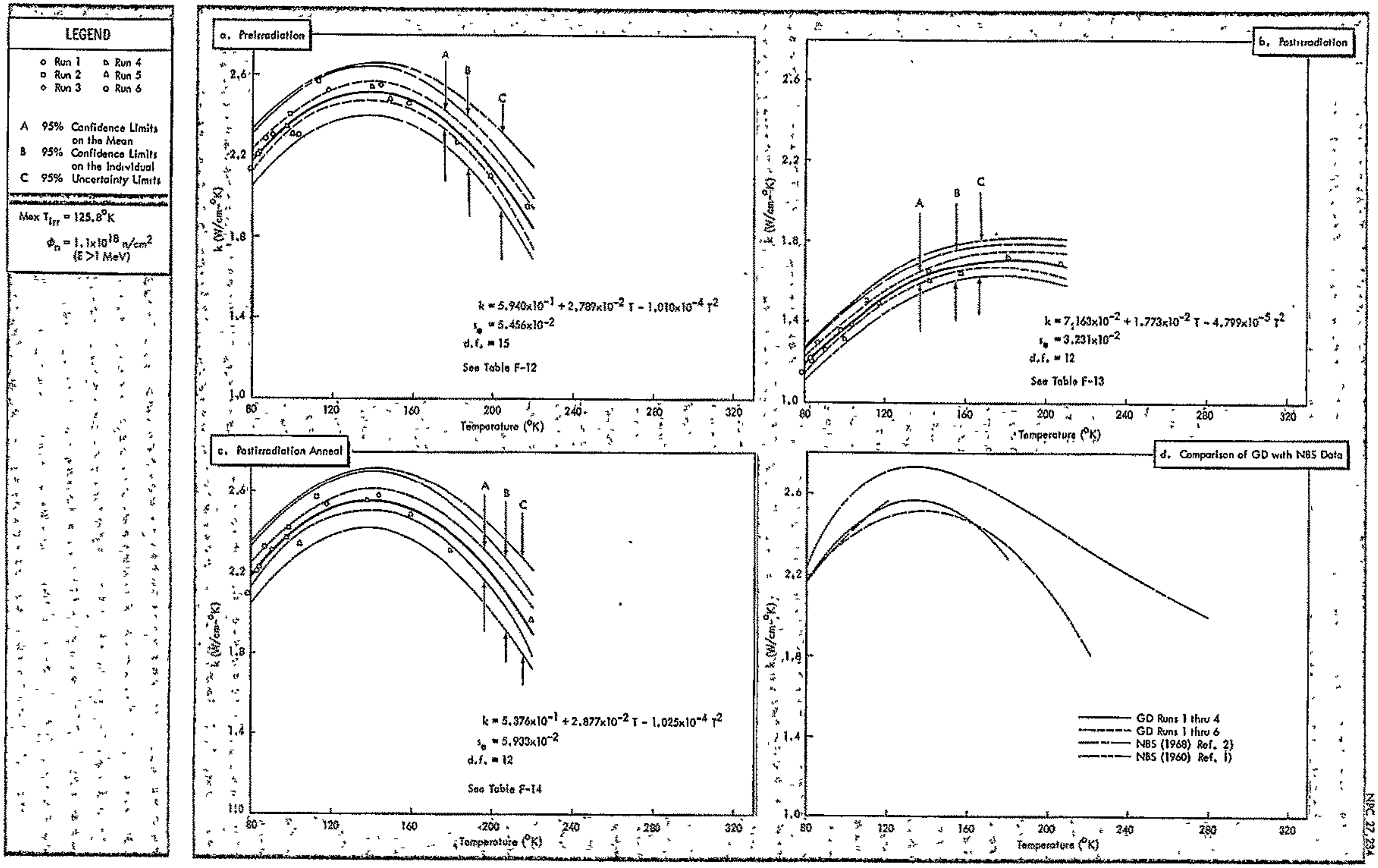

Figure 3-9 Thermal Conductivity of NBS Beryllium as a Function of Temperature for All Data Runs

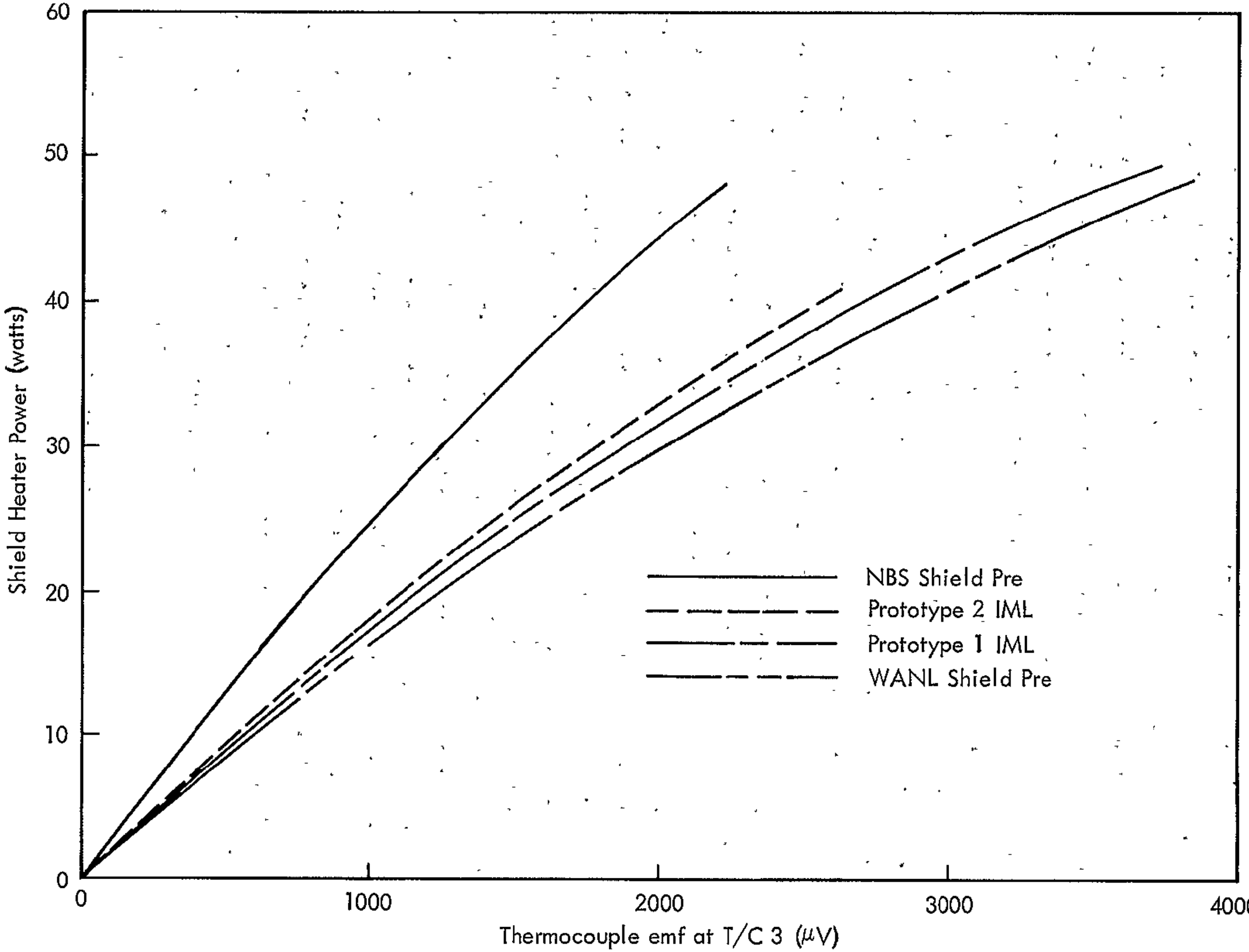

Figure 3-10 Shield Heater Power vs Thermocouple emf at T/C 3 for Beryllium Specimen

NPC 27,235

3.5.1.3 WANL Beryllium

A total of four data runs each were made in the preirradiation, postirradiation, and postirradiation-anneal tests. Figure 3-11 shows plots of the thermal conductivity vs temperature for selected data runs (Runs 1 through 3) for preirradiation, postirradiation, postirradiation-anneal, and the change in thermal conductivity due to irradiation. Figure 3-12 is plots of the thermal conductivity vs temperature for all data runs (Runs 1 through 4), and a comparison of the two preirradiation data curves. The systematic error for this specimen was less than 0.5%; therefore, the uncertainty limits and the confidence limits on the individual values are plotted as one. Although two sets of curves are shown for these data, the difference in the uncertainty of the two sets is less than 2.5%.

The preirradiation values of k determined from this test ranged from 2.998 watts/cm-^{o}K at 80^{o}K to 3.331 watts/cm-^{o}K at 120^{o}K to a minimum of 2.620 watts/cm-^{o}K at 180^{o}K. The postirradiation values of k determined from this ranged from 1.317 watts/cm-^{o}K at 80^{o}K to 1.846 watts/cm-^{o}K at 180^{o}K. The maximum percent change in k from preirradiation to postirradiaion occurred at 80^{o}K, where a decrease of approximately 56% was evident. As in the case of NBS beryllium, the percent change in k from pre- to postirradiation decreased as the temperature of the specimen increased and was approximately -30% at 180^{o}K. After the

specimen was warmed to room temperature for approximately 60 hours, the thermal conductivity measurements were repeated. The values of k determined from these postirradiation-anneal data fell within 1% of the preirradiation values, indicating complete recovery. Again, as in the case of NBS beryllium, the change from preirradiation to postirradiation-anneal indicated an increasing trend in the value of k. This could indicate some slight change in material properties; however, the change is within the precision of measurement and any definite statement concerning this change would be suspect.

During the postirradiation data cycle, thermal conductivity data were taken on the specimen up to a temperature of 180°K at T/C 3. The specimen was then allowed to return to LN_2 temperature and the data cycle repeated. As in the case of NBS beryllium, the data repeated to within the precision of measurement, and, therefore, it was concluded that annealing at 180°K, if any, was undetectable within the precision of measurement.

In summary, it can be stated that the change in k of WANL beryllium resulting from the radiation exposure of this experiment was significant ($\approx$ 56% at 80 K), and that the value of the thermal conductivity returned to approximately its preirradiation value after a room-temperature anneal.

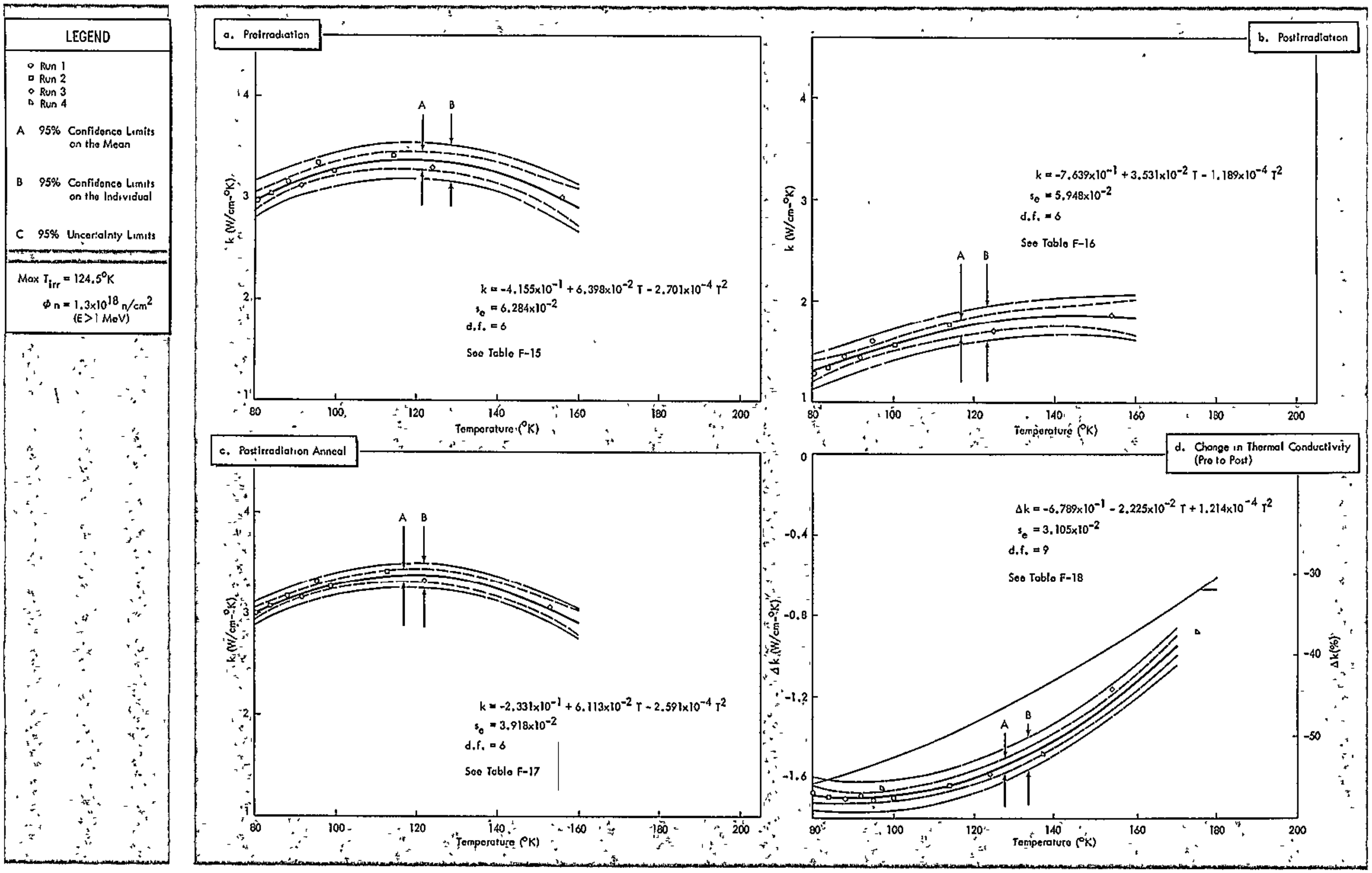

Figure 3-11 Thermal Conductivity of WANL Beryllium as a Function of Temperature for Selected Data Runs

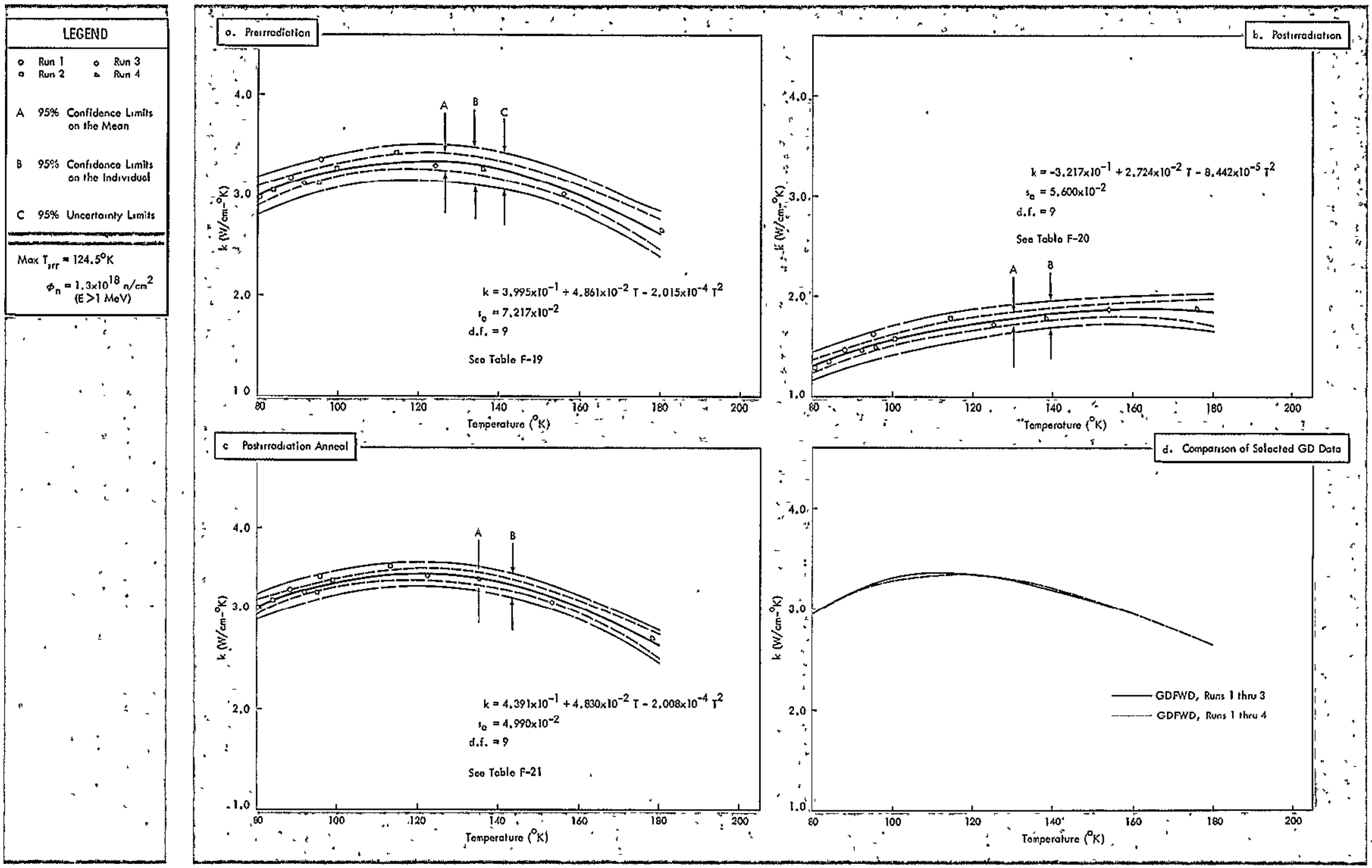

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Figure 3-12 Thermal Conductivity of WANL Beryllium as a Function of Temperature for All Data Runs

3.5.1.4 Titanium

A total of eight data runs were made in the preirradiation test, and four data runs each in the postirradiation and post-irradiation-anneal tests. Figure 3-13 is plots of the thermal conductivity of titanium vs temperature for selected runs for preirradiation (Runs 1 through 6), postirradiation (Runs 1 through 3), postirradiation-anneal (Runs 1 through 3), and the change in thermal conductivity due to irradiation. Figure 3-14 is plots of the thermal conductivity of titanium vs temperature for all data runs and a comparison of the preirradiation data with NBS data (Ref. 8),

The preirradiation values (selected data runs) for this test ranged from 0.0475 watt/cm-^{o}K at 80^{o}K to 0.0812 watt/cm-^{o}K at 270^{o}K. The preirradiation values from all data runs ranged from 0.0485 watt/cm-^{o}K at 80^{o}K to 0.0856 watt/cm-^{o}K at 270^{o}K to 0.1122 watt/cm-^{o}K at 390^{o}K. The postirradiation values (selected data runs) ranged from 0.0472 watt/cm-^{o}K at 80^{o}K to 0.0806 watt/cm-^{o}K at 270 K. The postirradiation values for all data runs ranged from 0.0475 watt/cm-^{o}K at 80^{o}K to 0.0870 watt/cm-^{o}K at 270^{o}K to 0.1142 watt/cm-^{o}K at 390^{o}K. The change in k from preirradiation to postirradiation is within the uncertainty limits.

In summary, it can be stated that, for the purposes of this experiment, there was no change in k of titanium as a result of the nuclear radiation level experienced.

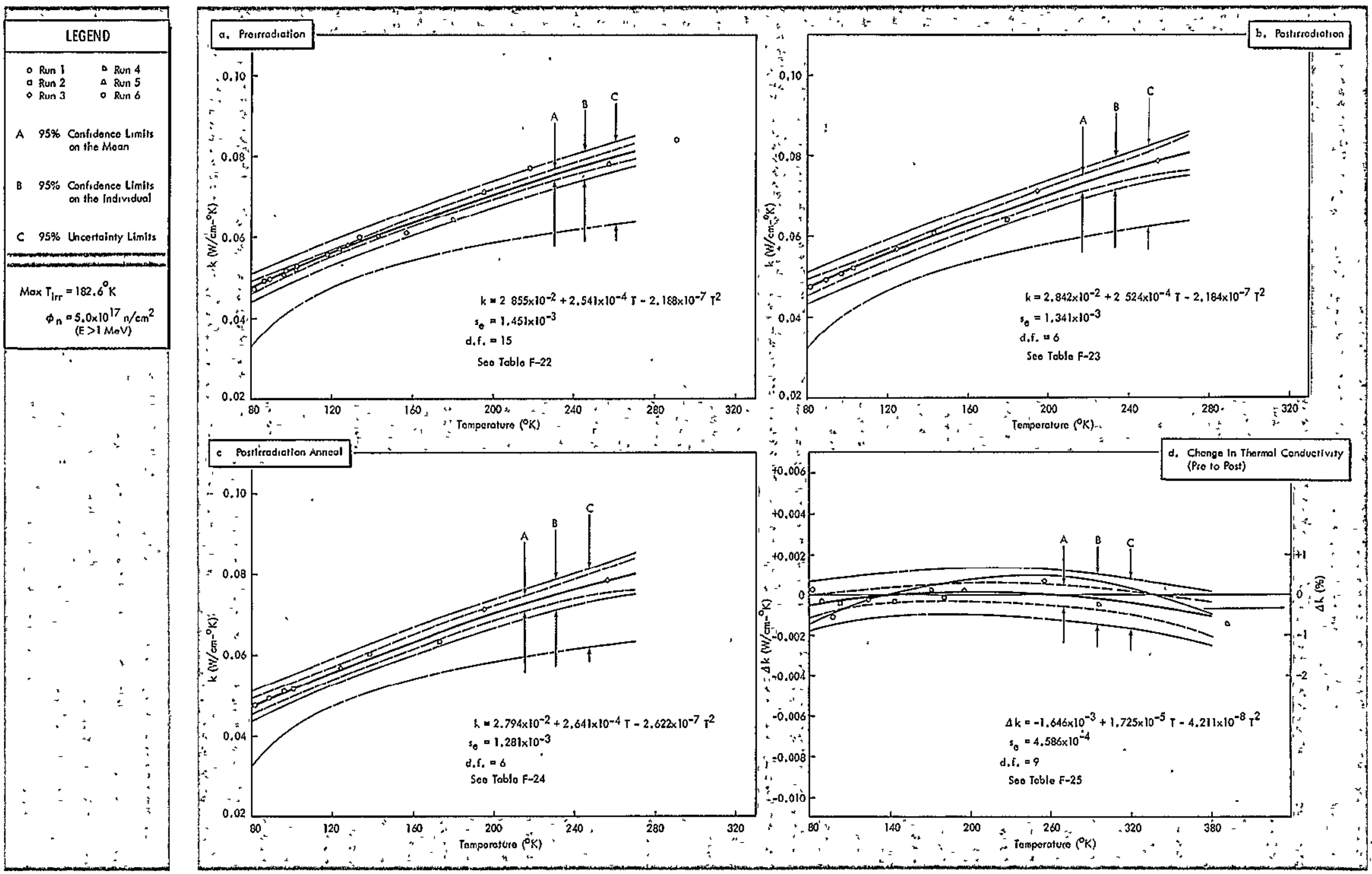

Figure 3-13 Thermal Conductivity of Titanium as a Function of Temperature for Selected Data Runs

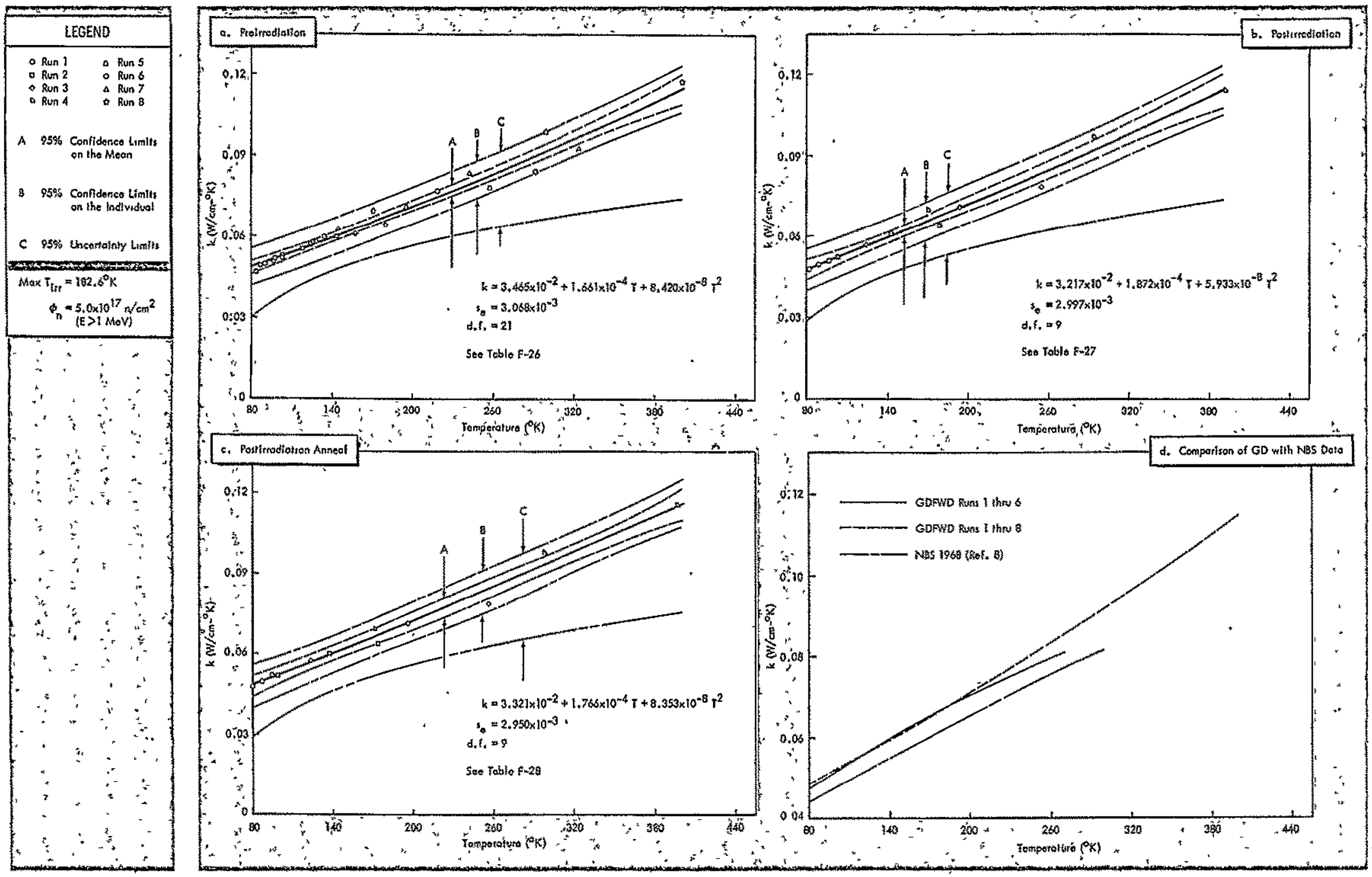

Figure 3-14 Thermal Conductivity of Titanium as a Function of Temperature for All Data Runs

NPC 27,239

3.5.1.5 PO-3 Graphite

A total of seven data runs were made in the preirradiation test, and five data runs each in the postirradiation and post-irradiation-anneal tests. Figure 3-15 is plots of the thermal conductivity of graphite vs temperature for selected data runs (Runs 1 through 4) for the preirradiation, postirradiation, and postirradiation-anneal tests, and the change in thermal conductivity due to irradiation. Figure 3-16 is plots of the thermal conductivity of graphite vs temperature for all data runs and a comparison of the preirradiation data with NBS (Ref. 9) and preliminary BMI data (Ref. 10).

From the preirradiation data in Figure 3-16(a), it is evident that there are rather excessive data shifts between runs. One occurs between Runs 2 and 3 and another between Runs 4 and 5. The reason for the large shifts between these runs is that a large ΔT step was made in each case requiring much more power to the shield and specimen heaters. For example, the shield- and specimen-heater powers for Run 2 were 8.69 and 1.15 watts, respectively. For Run 3, they were 29.49 and 5.07 watts, respectively. If smaller increments of power were applied to the heaters, these abrupt shifts in the data would not seem as apparent. This can be seen, somewhat, in Figure 3-8(a) of the aluminum data.

The preirradiation values of k for the selected data runs

ranged from 0.049 watt/cm-°K at 80°K to 0.305 watt/cm-°K at 280°K at 390°K. At 80°K the decrease in k from preirradiation to postirradiation is 72.7%, and decreases to a value of 61.1% at 280°K.

The postirradiation-anneal data indicated very little recovery. At 80°K the postirradiation-anneal value of k was 0.060 watt/cm-°K for the selected data runs, indicating a decrease from the preirradiation value of 66.9% as compared to 72.7% fo. the postirradiation value. While this difference of 5.8% is considered small, the experimental uncertainty at low temperatures is also small so this value probably does represent a recovery trend. At the higher temperatures any recovery trend is masked by the experimental uncertainty, which increases as the temperatures increase. At 370°K the postirradiation-anneal value of k is 0.494 watt/cm-°K, a decrease from the preirradiation value of 48.5% as compared to a decrease of 48.7% for the postirradiation value.

Figure 3-16(d) shows a comparison of the preirradiation data with NBS and preliminary BMI data. The NBS and preliminary BMI data were taken using the same specimen. This specimen was obtained from GDFWD where it was held as a spare for the GTR-21 test. Although the uncertainty in the GDFWD data is reported to range from 25% to 76%, the data agrees with the NBS and BMI data within 13% up to 280°K. The maximum deviation is 25% from the BMI data at 380°K. This would tend to give added confidence

in the data and certainly indicate that the uncertainty is not as large as it appears.

In an attempt to determine the annealing effects on the graphite specimen, a follow-on test was conducted several weeks after the irradiation. During this interim period the specimen was stored at room temperature.

Figures 3-17 through 3-20 are plots of the thermal conductivity of graphite vs temperature as obtained from the follow-on tests. These data are designated as IML Runs P4 through P15 and are given in Tables F-36 and F-47 of Appendix F. Three different reference baths - liquid nitrogen, ice water, and boiling water - were used to obtain data to a maximum temperature of 470°K. It should be noted, again, that a new test unit had to be constructed and, thus, constituted a new experiment. Following is a list of the different test runs and a descriptive remark about the difference in configurations. The remark "fiber glass" means that fiber glass was packed in the void between the shield and the specimen.

IML Run	Reference Bath	Configuration
P4	LN_2	Fiber glass
P5	LN_2	No fiber glass
P6	LN_2	Fiber glass
P7	LN_2	Fiber glass; new shield heate-

IML Run	Reference Bath	Configuration
P8	Ice Water	Fiber glass
P10	Boiling Water	Fiber glass
P11	LN_2	Fiber glass; new shield and specimen heaters
P12	LN_2	Fiber glass and added fiber glass between heaters
P13	LN_2	Same configuration as irradiation unit.
P14	Boiling Water	Fiber glass
P15	Boiling Water	Fiber glass

The installation of high-density fiber glass in the void between the shield and the specimen was to reduce the heat leakage between the two because of the difference in the value of k between the irradiated specimen and the unirradiated shield. The first two runs, P4 and P5, were made with and without fiberglass packing to see if the heat leakage was reduced by adding the fiber glass. A comparison of the data from Runs P4 and P5, Figure 3-17(a and b), shows a decrease of 4.7% in k at 80 K and an increase of 4.8% at 400 K. It is difficult to draw any definite conclusions from these data because (1) the test apparatus was disturbed by opening it to add or remove the fiber glass, and (2) annealing of the specimen was taking place. It does indicate that the thermal leakage is reduced at the higher temperatures, although the change in k is overshadowed by the uncertainty

in the data.

Figure 3-20 shows plots of the mean curves for all graphite data. At the completion of the follow-on test, approximately 50% of the damage to the specimen had been annealed out.

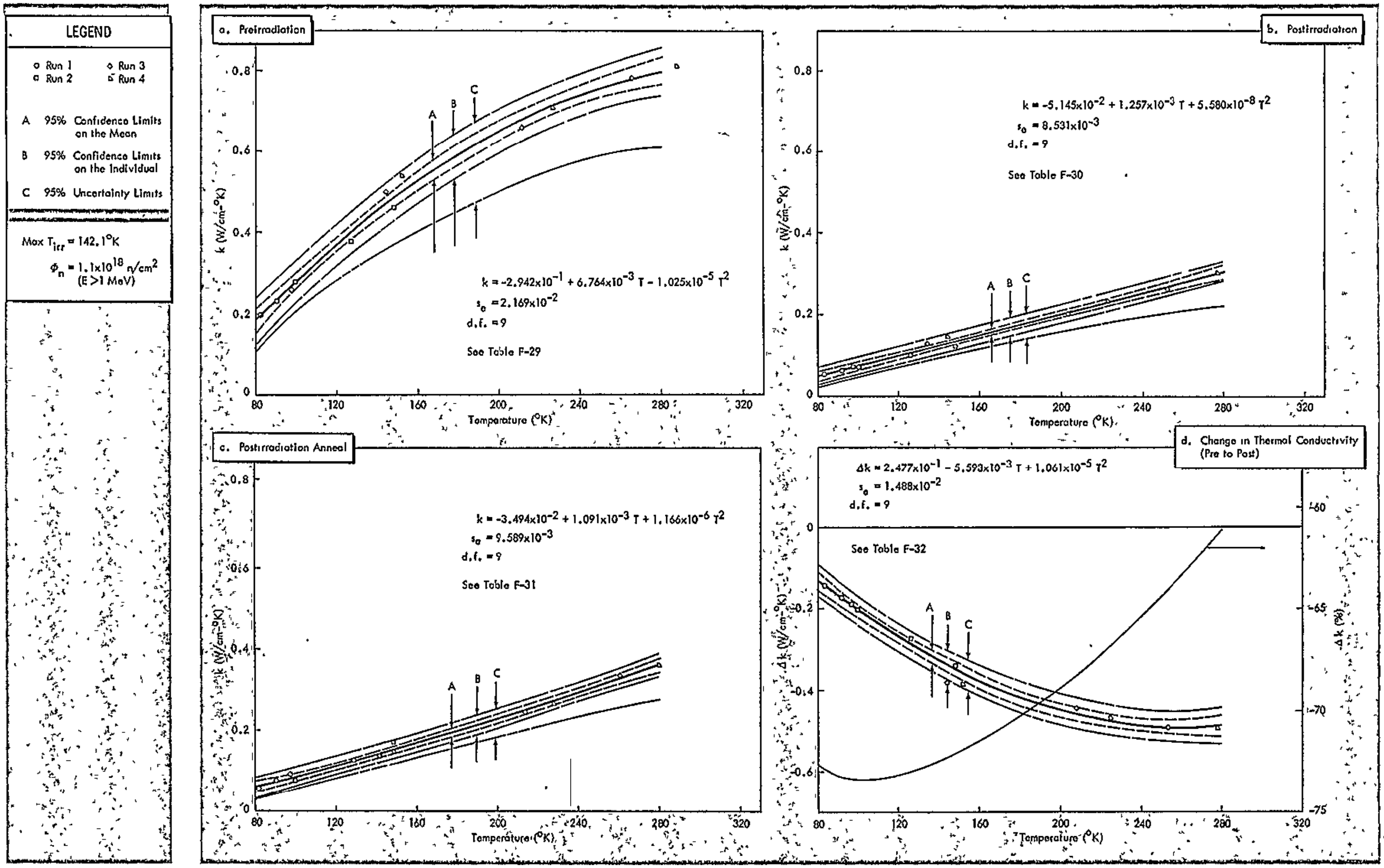

Figure 3-15 Thermal Conductivity of PO-3 Graphite as a Function of Temperature for Selected Data Runs

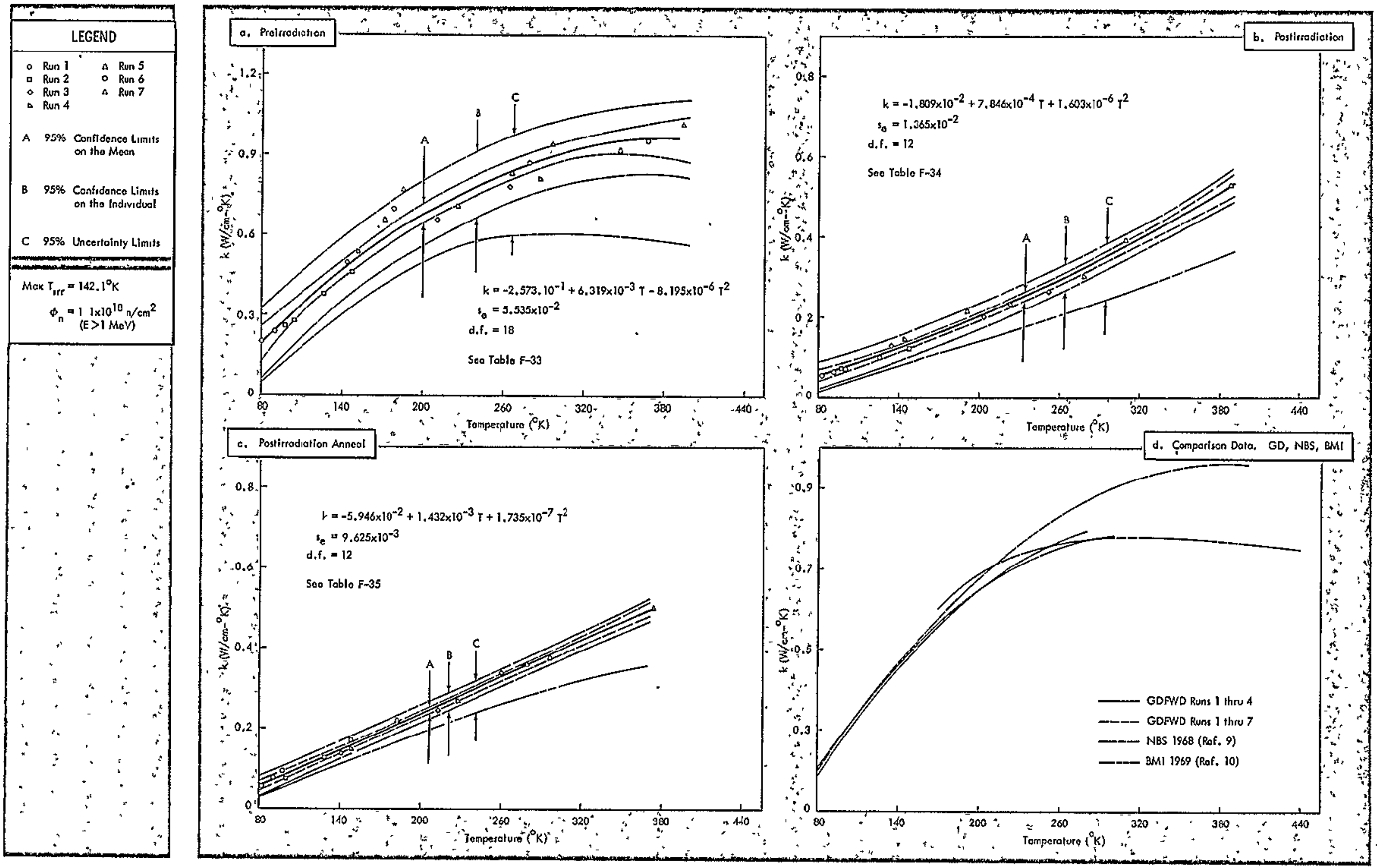

Figure 3-16 Thermal Conductivity of PO-3 Graphite as a Function of Temperature for All Data Runs

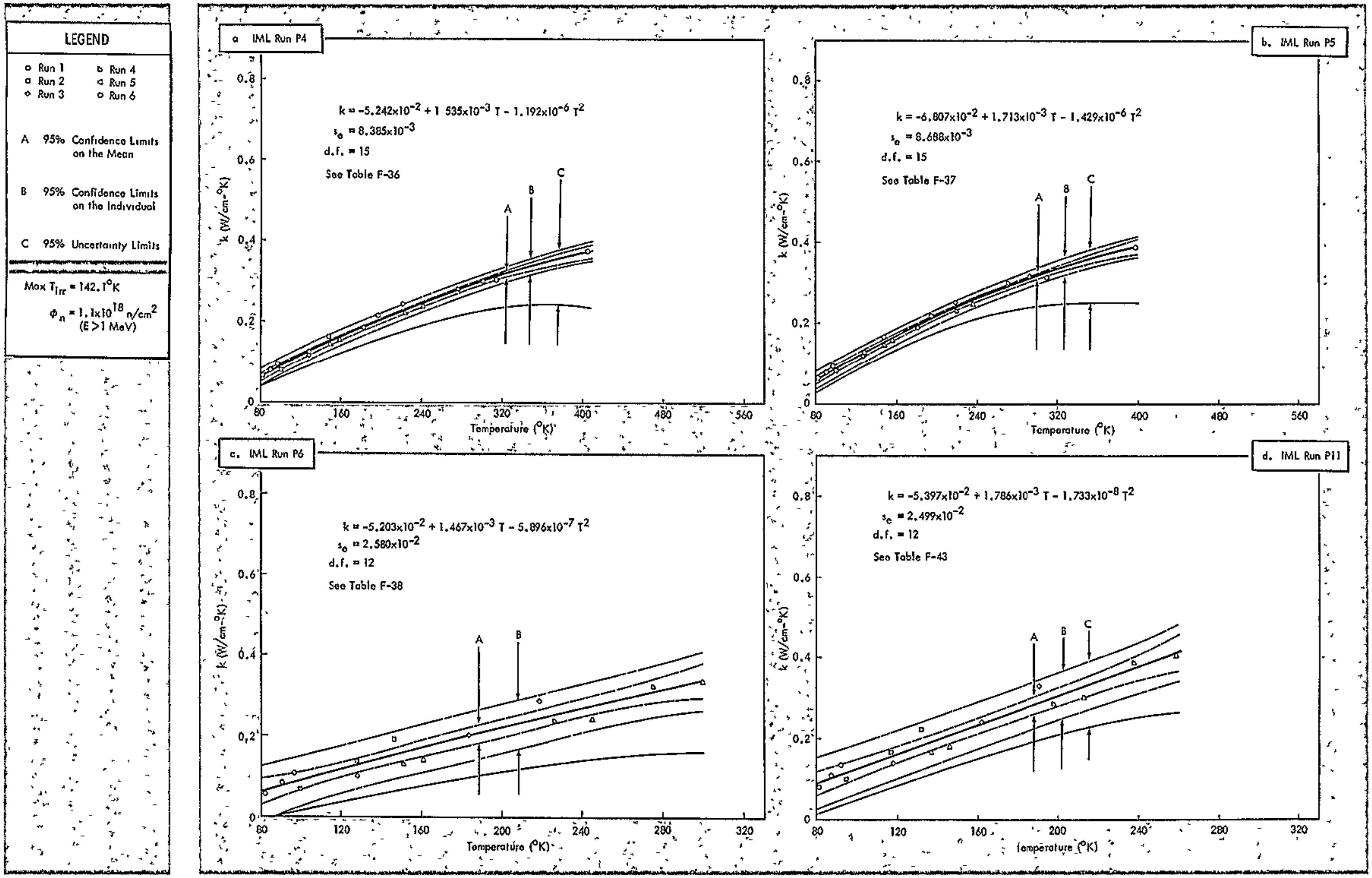

Figure 3-17 Thermal Conductivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs P4, P5, P6, and P11

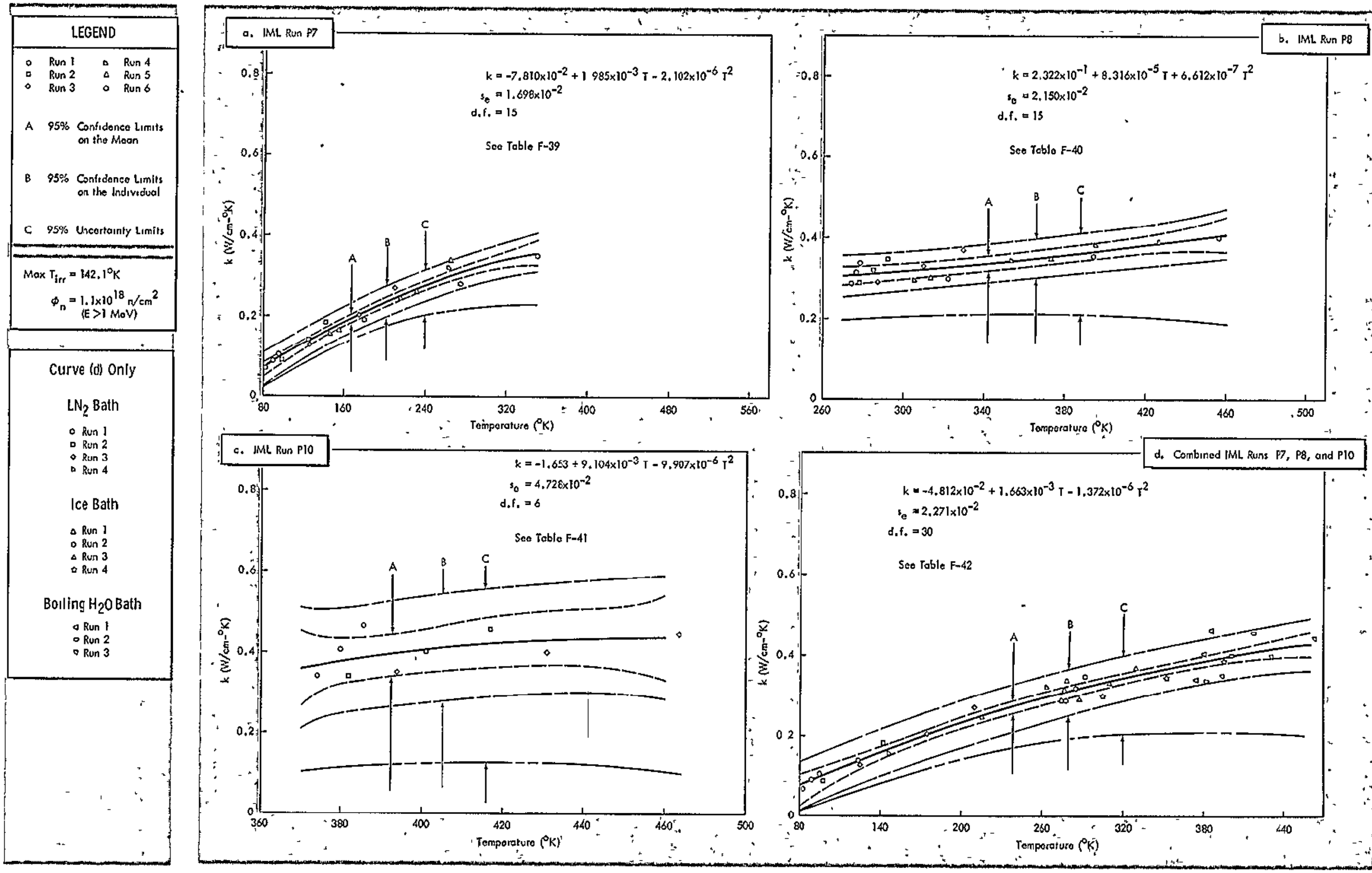

Figure 3-18 Thermal Conductivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs P7, P8, and P10

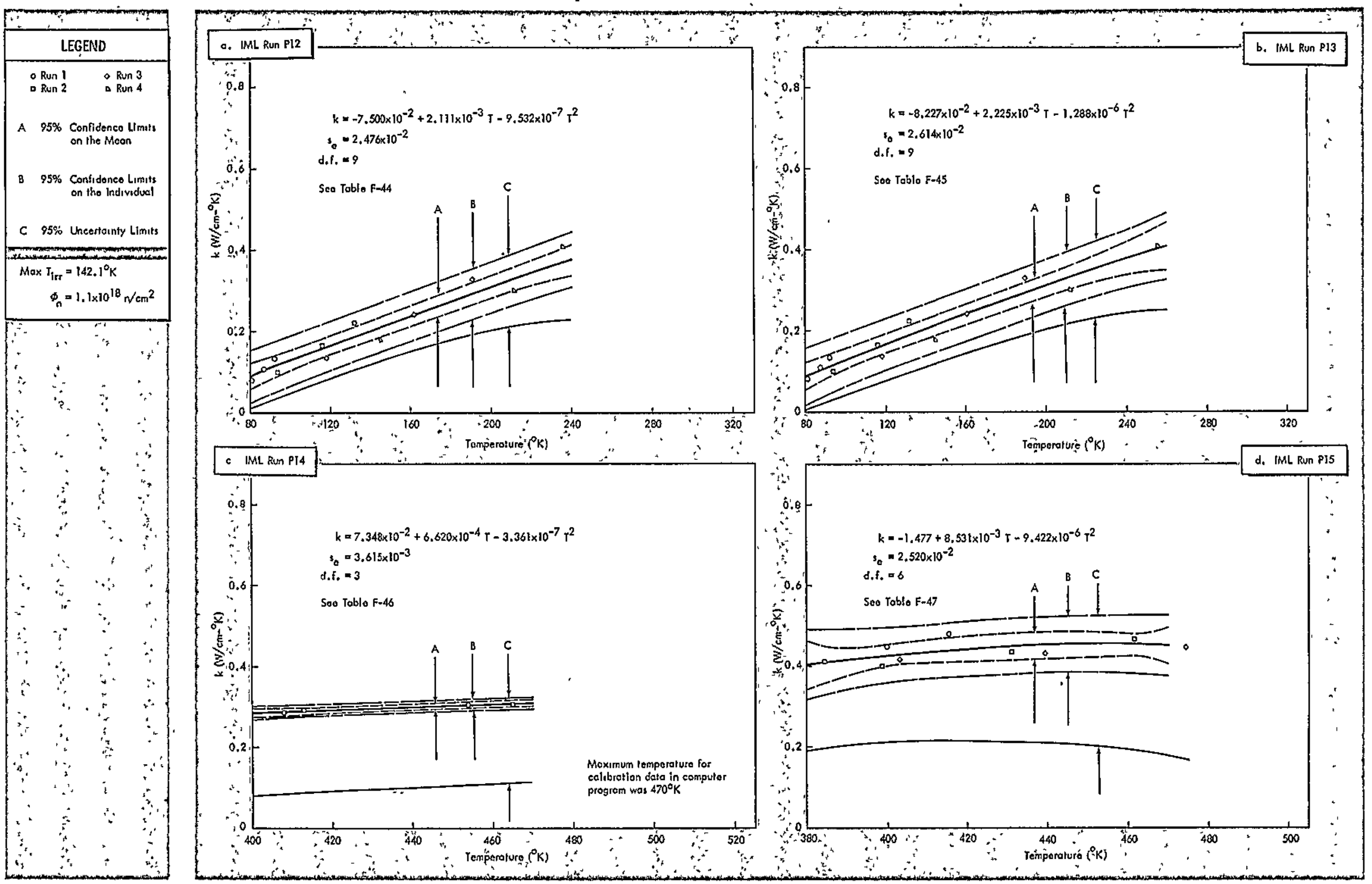

Figure 3-19 Thermal Conductivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs P12, P13, P14, and P15

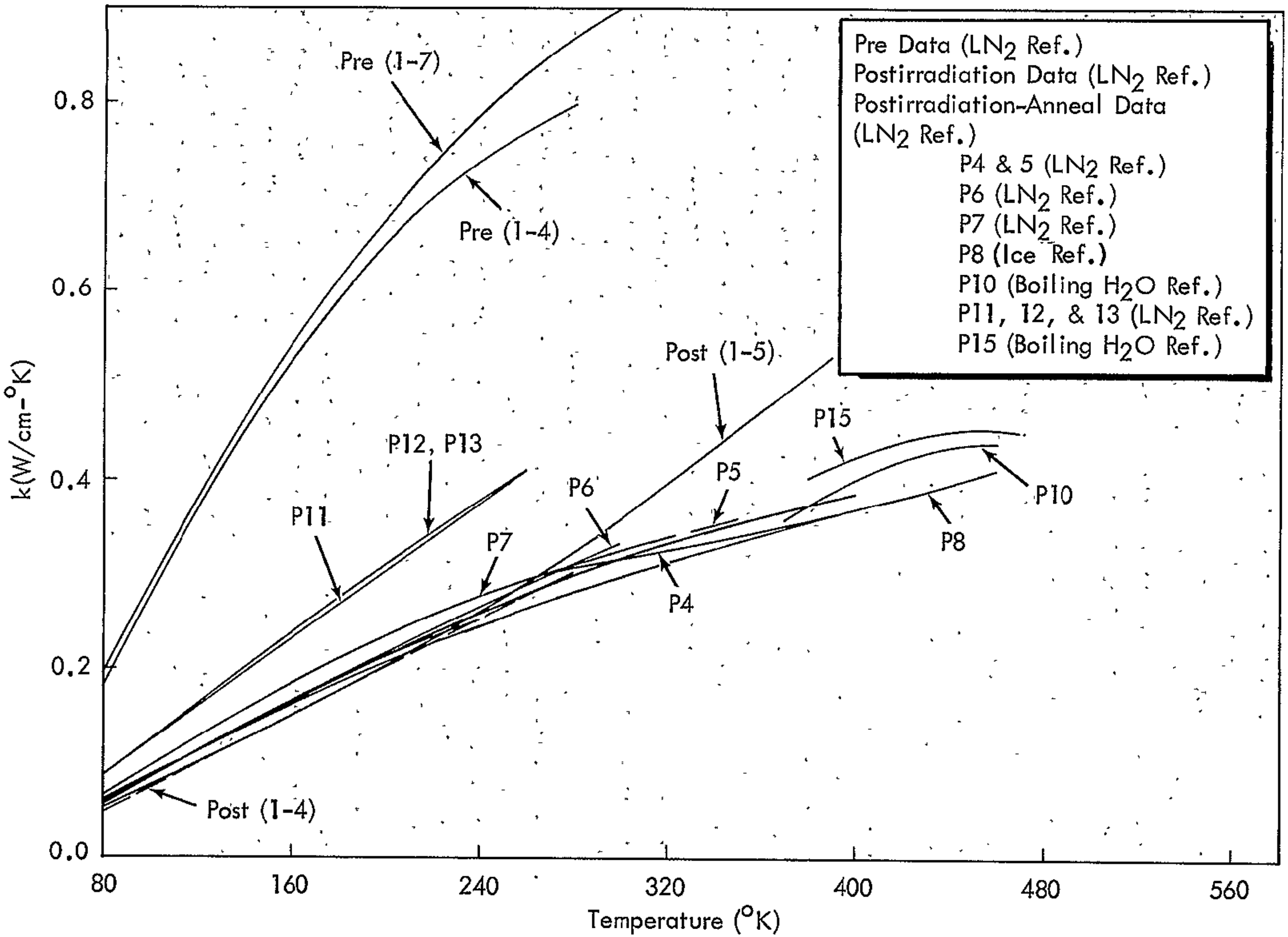

Figure 3-20 Thermal Conductivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs

NPC 27,245

3.5.2 Summary

Of the materials tested, the graphite specimen exhibited the largest radiation-induced change (72.7%) in the value of k after exposure to the radiation levels of this experiment. The titanium and aluminum specimens exhibited very small changes in k. Of the two beryllium specimens tested, the WANL beryllium indicated a change of approximately 56%, while the NBS beryllium indicated a change of approximately 45%.

All of the materials significantly affected by the radiation levels of this experiment (graphite, NBS beryllium, and WANL beryllium) experienced decreases in thermal conductivity. The percent change in the value of k was greater at the lower temperatures than at the higher temperatures, indicating that the change in k is temperature-dependent.

Aluminum and titanium showed no significant change ($< 5\%$) in k from preirradiation to postirradiation.

The NBS beryllium and WANL beryllium indicated no detectable recovery towards their preirradiation value of k after warmup to 180°K. However, after warmup to room temperature, all the materials except graphite regained, or came close to regaining, their preirradiation value. The graphite specimen experienced only a slight recovery after the room-temperature anneal. The results of a follow-on test on graphite indicated that approximately 50% of the damage had been annealed out.

3.6 Electrical Resistivity Test

The electrical resistivity raw experimental data taken before and after the irradiation are tabulated, along with the thermal conductivity data, in Tables E-1 through E-15 of Appendix E. An explanation of the data appearing in these tables is presented at the beginning of Appendix E. The electrical resistivity values calculated from the raw data are plotted in Figures 3-21 through 3-38 as a function of average specimen temperature. These data, along with the temperature data and electrical resistivity data measured during the irradiation, are presented in Tables F-63 through F-100 of Appendix F. The temperatures given for the electrical resistivity data during irradiation are those of the specimen at the location of T/C 2.

The method used to obtain the electrical resistivity values from the raw data is discussed below.

3.6.1 Data Analysis

The resistivity of the specimen was calculated from the forumula

$$\rho = R \frac{A}{L}$$

In this relationship, A is the area of the specimen (see Sec. 2.1); L is the distance between the upper and lower thermocouples and is the same (14 cm) for all specimens; R is the resistance determined from the data in Appendix E by means of the relationship

$$R = \frac{R_F + R_R}{2}$$

where

R_F = resistance in forward direction

$$= \frac{\text{volts across specimen in forward direction}}{\text{current through specimen in forward direction}}$$

$$= \frac{\text{resistance forward } (\mu V) - \text{thermoelectric power } (\mu V)}{\text{volts forward (V)}/9.745}$$

R_R = resistance in reverse direction

$$= \frac{-\text{resistance reverse } (\mu V) + \text{thermoelectric power } (\mu V)}{\text{volts reverse (V)}/9.745}$$

In the equations for R_F and R_R, the resistance forward and resistance reverse is the emf output between T/C 1 and T/C 3 with current flow through the specimen in the forward and reverse directions, respectively; the thermoelectric power is the emf output between T/C 1 and T/C 3 with no current flow; and the volts forward is the voltage drop across a 9.745-Ω resistor in series with the test specimen. All data required to calculated R_F and R_R are presented in Tables E-1 through E-15 for each temperature gradient across the specimen.

To illustrate use of the experimental data in obtaining ρ, the preirradiation value of the resistivity of aluminum at 0° ΔT was calculated as follows:

From the geometry of the specimen, A = 0.153 cm^2 and L = 14 cm.

From Table E-1

$$R_F = \frac{[91.1 - (-1.6)] \times 10^{-6}}{4.8510/9.745} = \frac{92.7 \times 10^{-6}}{0.49779} = 186.22 \times 10^{-6}\ \Omega$$

$$R_R = \frac{\left[-(-95.2) + (-1.6)\right] \times 10^{-6}}{4.8805/9.745} = \frac{93.6 \times 10^{-6}}{0.50082} = 186.89 \times 10^{-6}\ \Omega$$

$$R = \left[\frac{186.22 + 186.89}{2}\right] \times 10^{-6} = 186.55 \times 10^{-6}\ \Omega$$

Substitution of A, L, and R into the resistivity formula yields

$$\rho = 186.55 \times 10^{-6}\Omega \times \frac{0.153\ \text{cm}^2}{14\ \text{cm}} = 186.55 \times 0.01093\ \mu\Omega\text{-cm}$$

$$\rho = 2.0388\ \mu\Omega\text{-cm}$$

When the resistivity was determined for various conditions of power input to the heaters, ρ was plotted against the average temperature of the specimen. This average was determined from the temperatures indicated by T/C 1, T/C 2, and T/C 3. It is known that this average temperature is not the <u>true</u> temperature for the value of ρ calculated. Electrical resistivity is a function of the temperature, and therefore the value of ρ, at any point on the specimen, is dependent upon its distance from the heat source. Therefore, some error is involved in assigning the calculated ρ to the average specimen temperature. In fact, where a temperature gradient exists across a specimen, there is no <u>true</u> value of temperature to assign to the calculated value of ρ.

Electrical resistivity values as a function of temperature are accurate to within 1% at temperatures approaching that of the reference bath, because the specimen temperature gradients are small. The accuracy decreases as the temperature gradient increases and, from experimental evidence, could be in error on

the order of 3% at the higher temperatures. Although this error does exist, for the purposes of this experiment the results are not significantly affected by a possible error in ρ of this magnitude.

3.6.2 Discussion of Results

The following is a general discussion of the results of this test based on the interpretation of the curves of Figures 3-21 through 3-38. An estimate of the effects of reactor radiation on the electrical resistivity of the materials tested is given, based on the change in ρ from preirradiation to postirradiation. A comparison between the GDFWD data and NBS data is made.

The electrical resistivity data measured during irradiation with the reactor at power is confounded by the effect of temperature on the electrical resistivity. As is evident from Table F-100, the temperature (even with helium flooding of the test units) increased considerably with increasing reactor power level and, accordingly, this temperature increase affected the electrical resistivity. Because of the dependence of electrical resistivity on temperature and, in turn, the dependence of temperature on power level, the electrical resistivity fluctuated with power-level changes throughout the irradiation. In view of this, the only significant resistivity data taken during the radiation period were those data taken during reactor shutdowns when the

temperature of the specimen approached that of the cryogen reference bath. This was the only condition under which the specimen temperature was constant as a function of time and therefore could be correlated with radiation exposure. These data, for each specimen, are shown in graphical form.

3.6.2.1 Aluminum

The plots of the electrical resistivity of aluminum as a function of temperature for the test conditions of this experiment are presented in Figure 3-21. The uncertainty limits of these data are less than 1.5% and are therefore not plotted. The resistivity increased by 8.1% at $80^{o}K$ after exposure to the radiation levels of this experiment as shown in Figure 3-21(d). The percent change from the preirradiation data to the postirradiation data decreased as the temperature of the specimen was increased, and at $260^{o}K$ the change was less than 1%. After a room-temperature anneal for 60 hours, recovery was complete.

Figure 3-22 presents the NBS data (Ref. 8) and the mean-curve plots of the GDFWD data. Although it is not detectable from this figure, the deviation of the preirradiation GDFWD data from the NBS data is less than 1% over the entire temperature range.

The electrical resistivity of aluminum as a function of neutron fluence is presented in Figure 3-23. As can be seen, the resistivity increased as a linear function of neutron fluence.

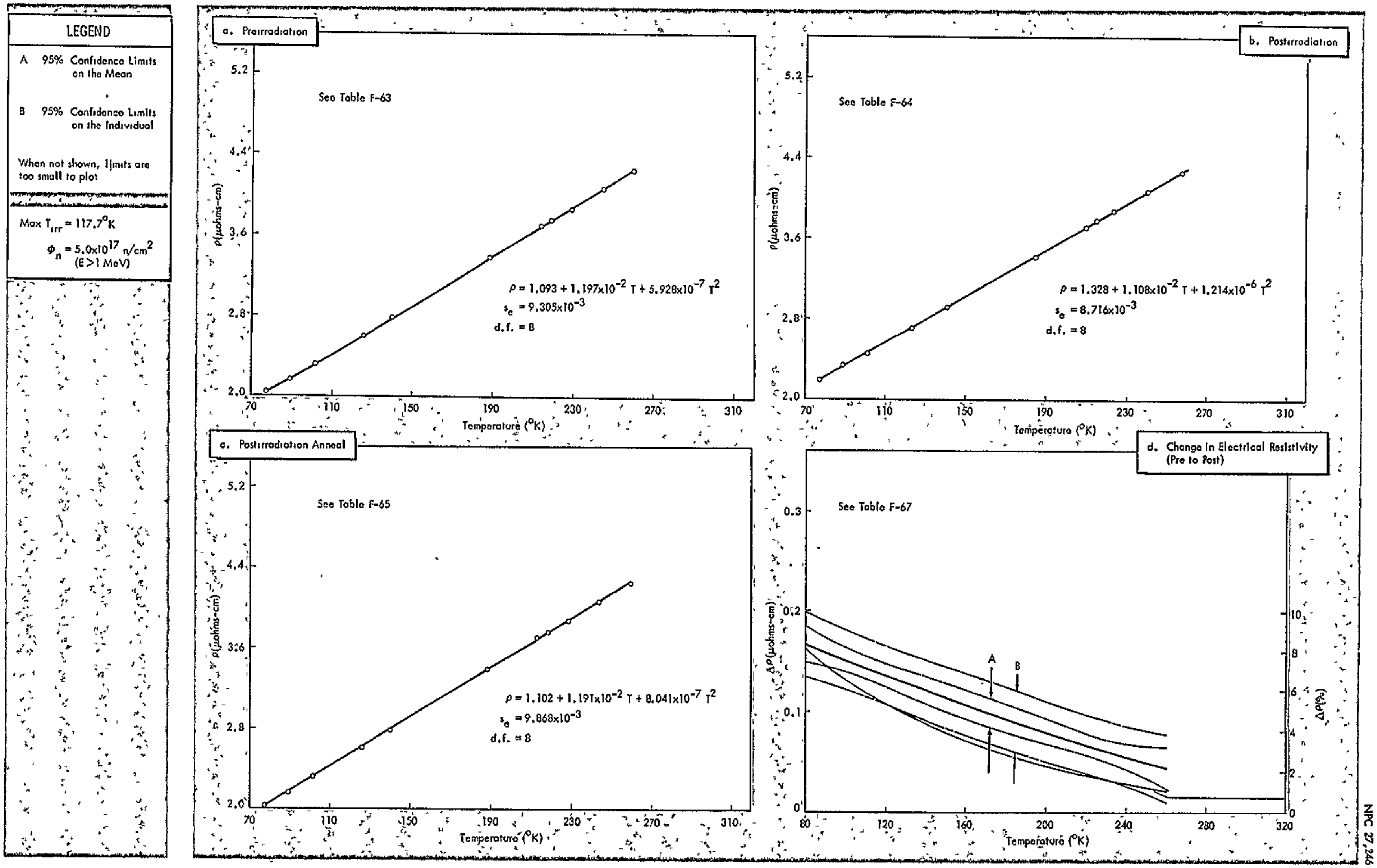

Figure 3-21 Electrical Resistivity of Aluminum as a Function of Temperature

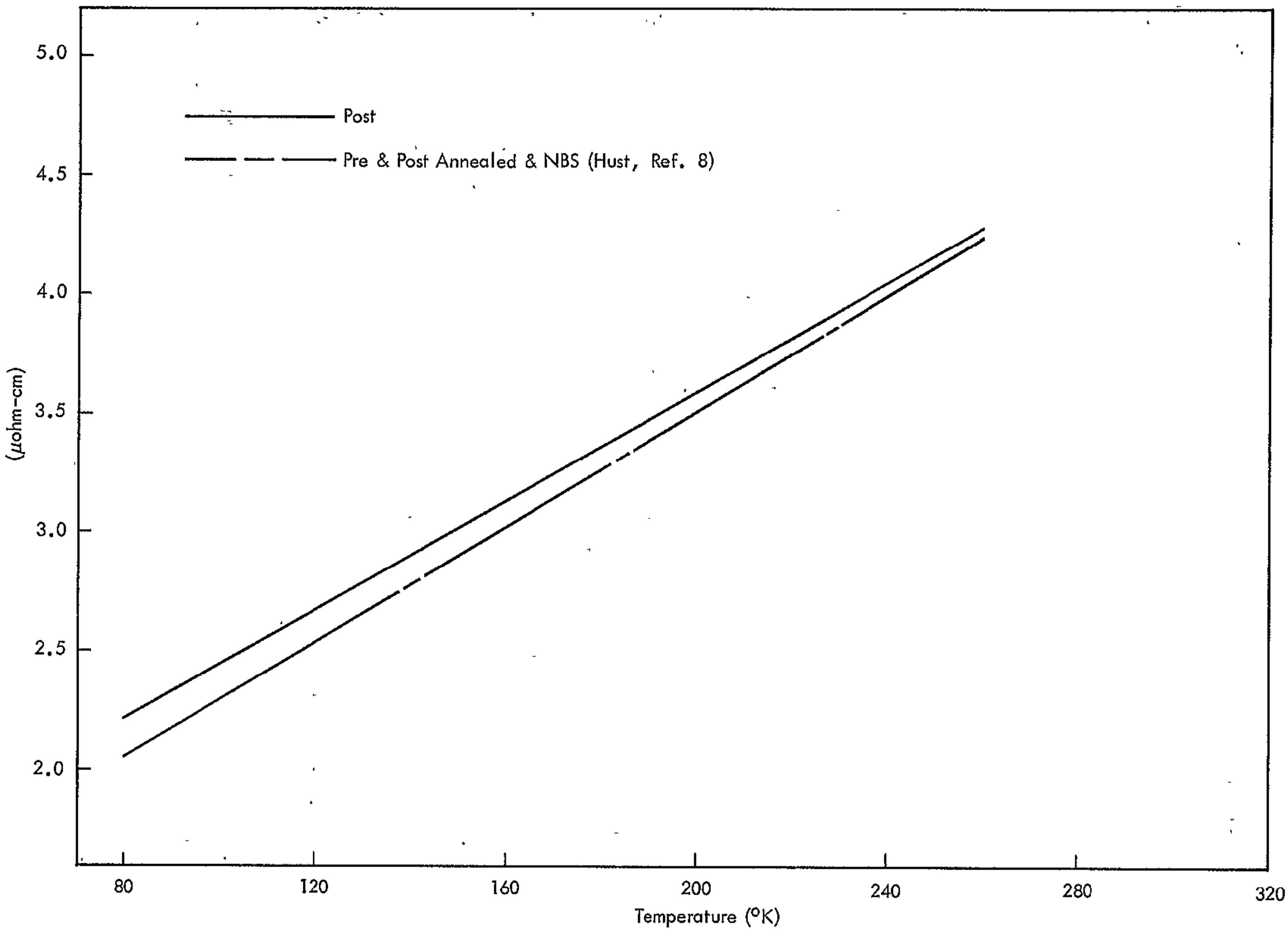

Figure 3-22 Comparison of GDFWD and NBS Electrical Resistivity for Aluminum

NPC 27,247

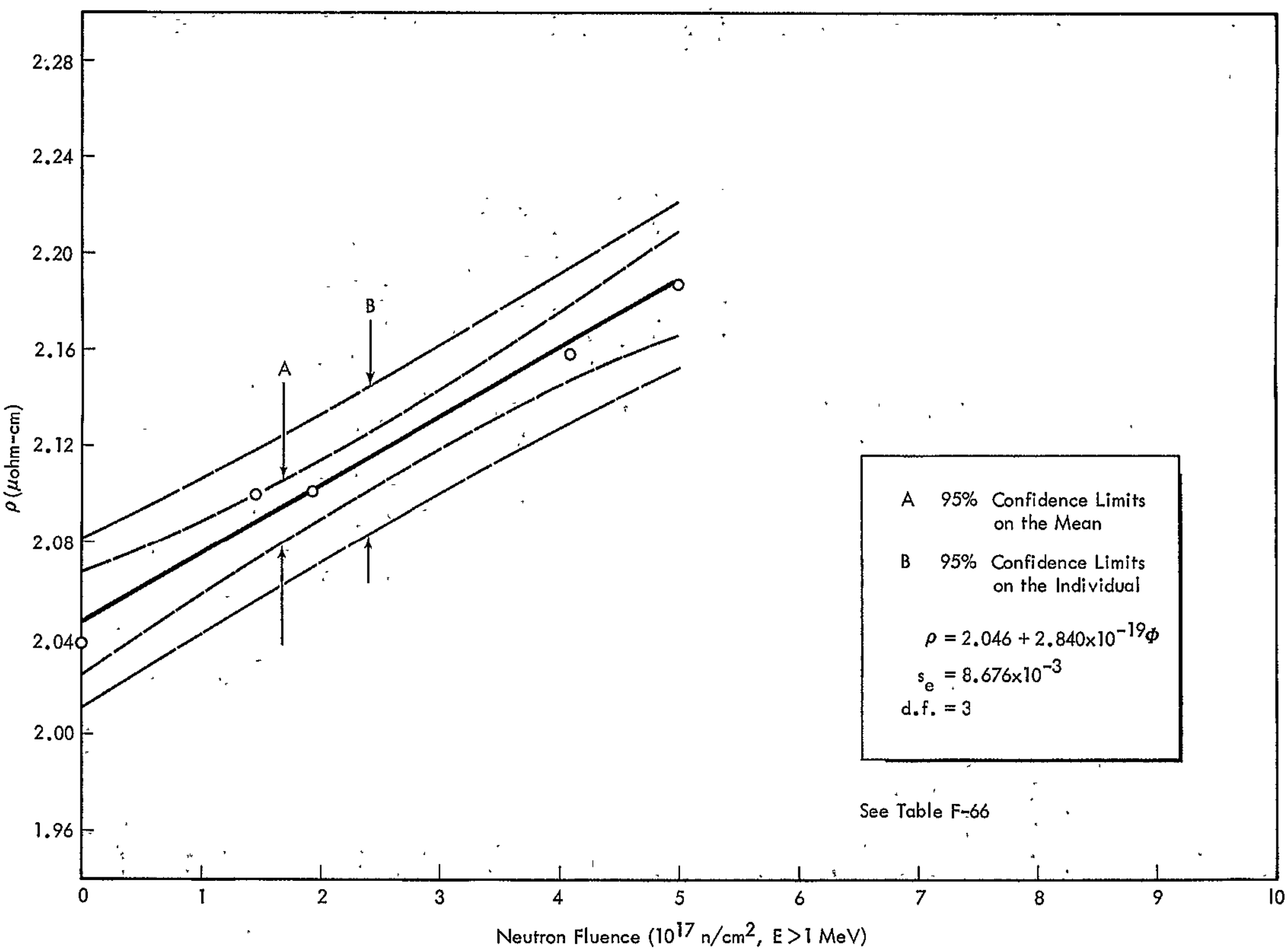

Figure 3-23 Electrical Resistivity of Aluminum as a Function of Radiation Exposure at Zero Reactor Power

3.6.2.2 NBS Beryllium

The plots of the electrical resistivity of NBS beryllium as a function of temperature are presented in Figure 3-24. The resistivity increased by approximately 72% at 80°K after exposure to the radiation levels of this experiment. The percent change decreased as the specimen temperature was increased and approached 50% at 140°K.

A comparison of the calculated ρ values for the NBS beryllium as a function of temperature for the GDFWD and NBS data (Ref. 2) is presented in Figure 3-27 along with the WANL beryllium data. The GDFWD data is in excellent agreement (< 1%) with the NBS data at 80°K, but deviates from the NBS data by a maximum of 3.2% at 160°K. The same specimen was used by both facilities and better correlation of data at higher temperatures was expected. The reason the data deviates at higher temperatures is probably because of errors in the GDFWD-assigned values of temperatures. In the GDFWD apparatus, since no floating heat sink was used, large temperature gradients were required across the specimen to obtain ρ at higher temperatures, resulting in larger errors in the calculated value of T to assign to a calculated value of ρ.

The electrical resistivity of NBS beryllium as a function of neutron fluence is presented in Figure 3-25. The resistivity is a linear function of neutron fluence.

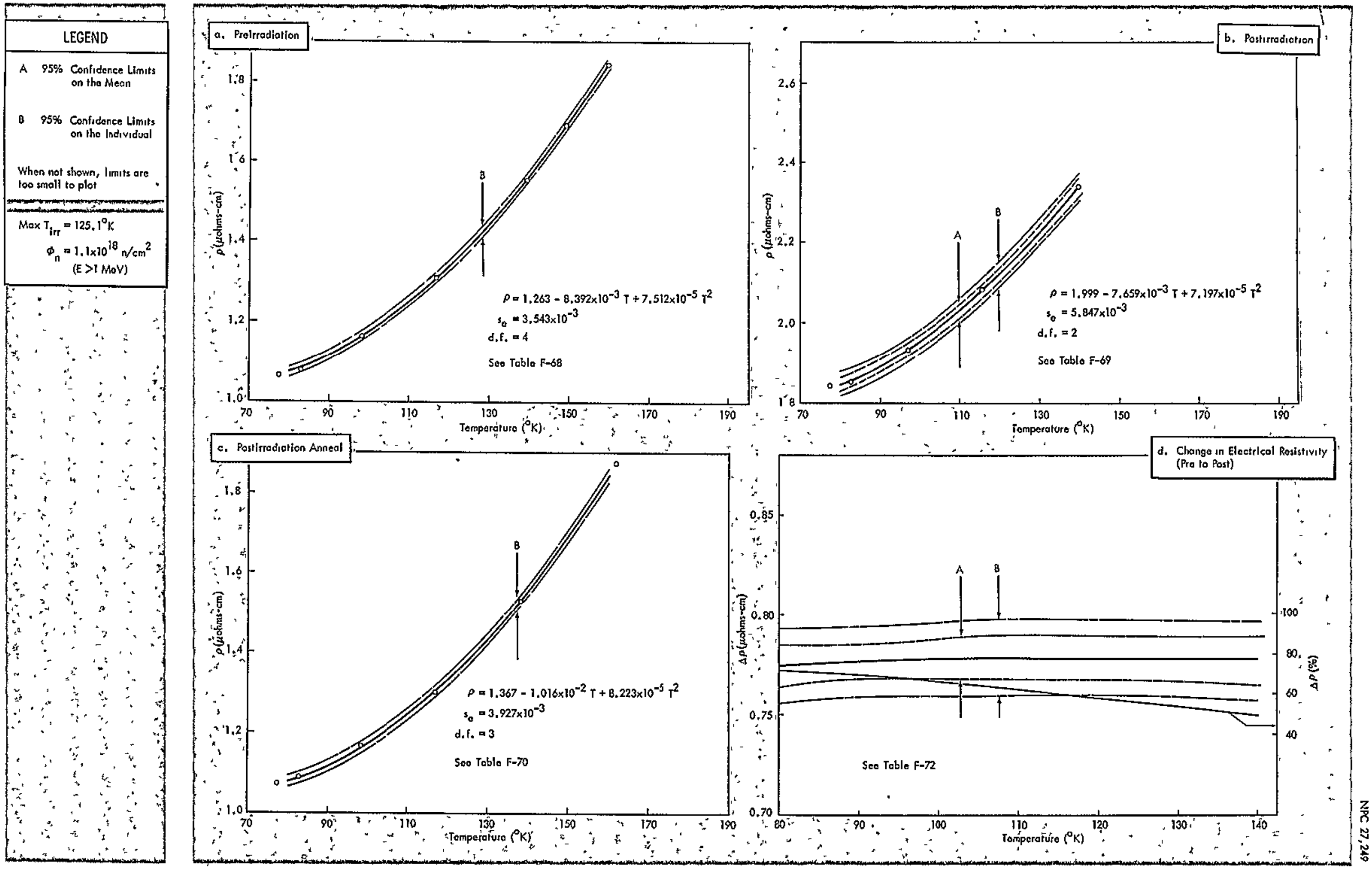

Figure 3-24 Electrical Resistivity of NBS Beryllium as a Function of Temperature

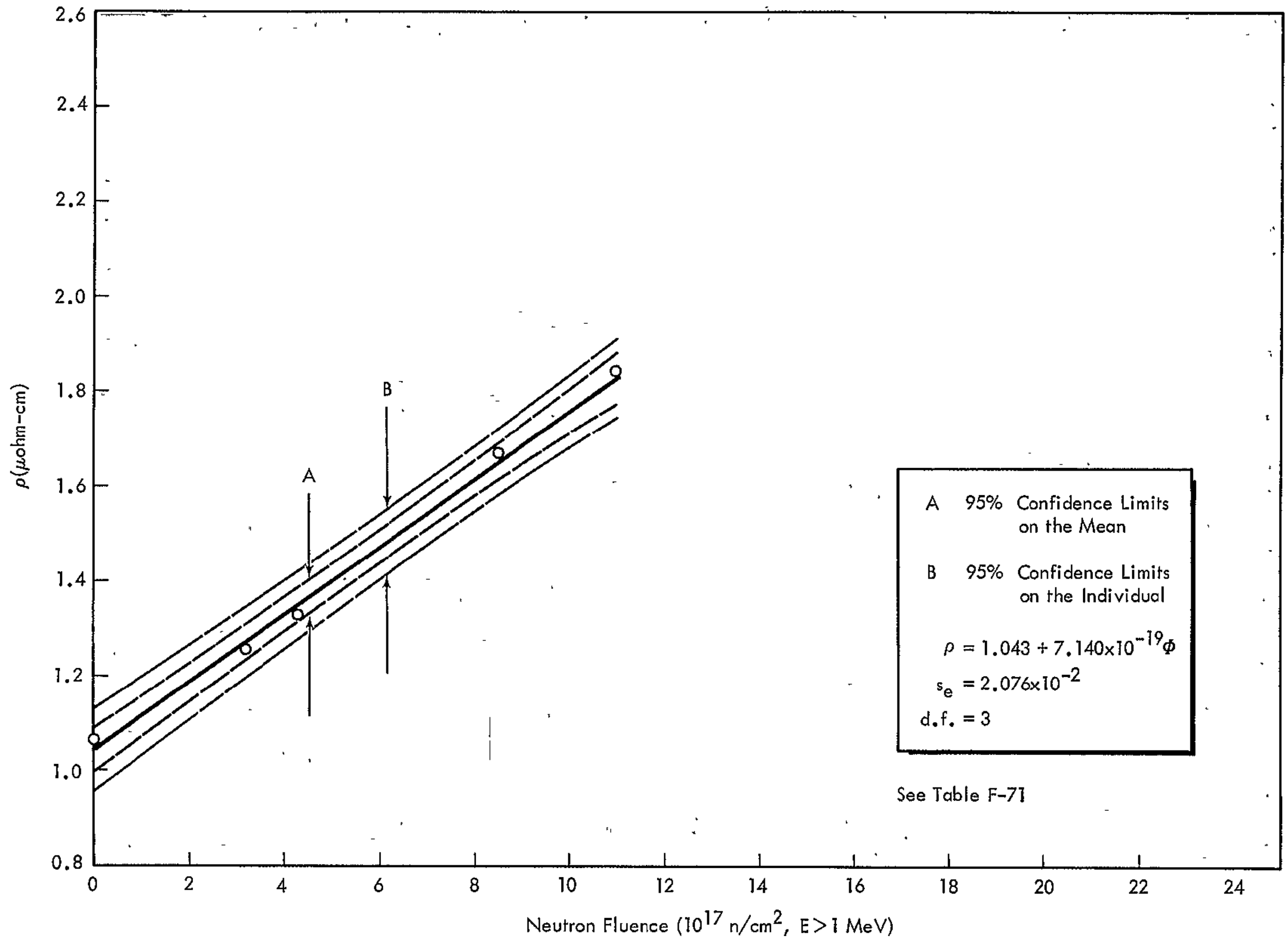

Figure 3-25 Electrical Resistivity of NBS Beryllium as a Function of Radiation Exposure at Zero Reactor Power

NPC 27,250

3.6.2.3 WANL Beryllium

The electrical resistivity data for the WANL beryllium are presented in Figure 3-26. The resistivity increased by approximately 131% at $80^{o}K$ after exposure to the radiation levels of this experiment. As in the case of aluminum and NBS beryllium, the percent change decreased as the temperature was increased, approaching an increase in resistivity of 84% at $140^{o}K$. A comparison of the WANL beryllium data with the NBS beryllium data is shown in Figure 3-27.

The electrical resistivity of WANL beryllium as a function of neutron fluence is presented in Figure 3-28. Again, this shows a linear relationship with neutron fluence.

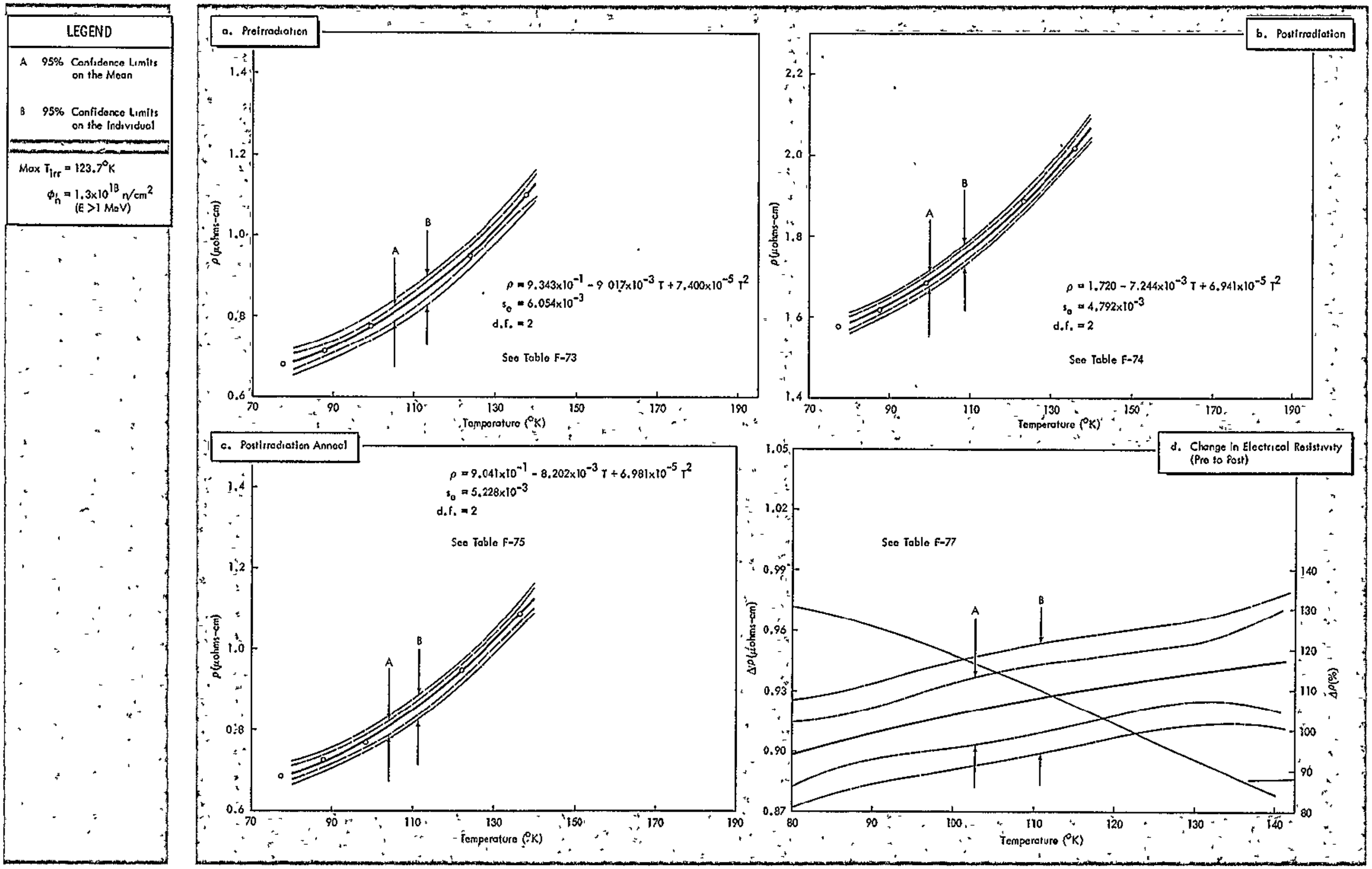

Figure 3-26 Electrical Resistivity of WANL Beryllium as a Function of Temperature

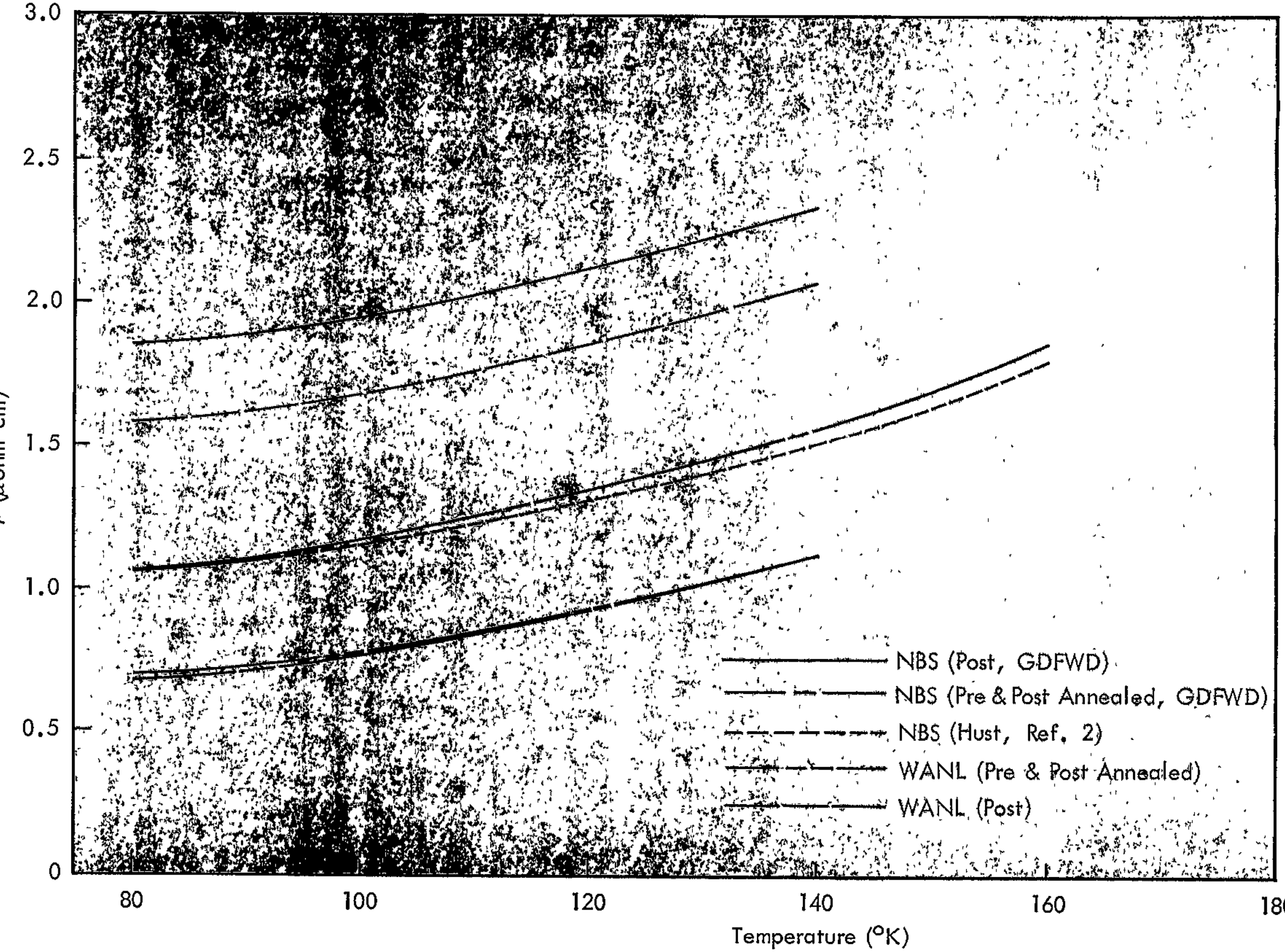

Figure 3-27 Comparison of GDFWD and NBS Electrical Resistivity for Beryllium

NPC 27,252

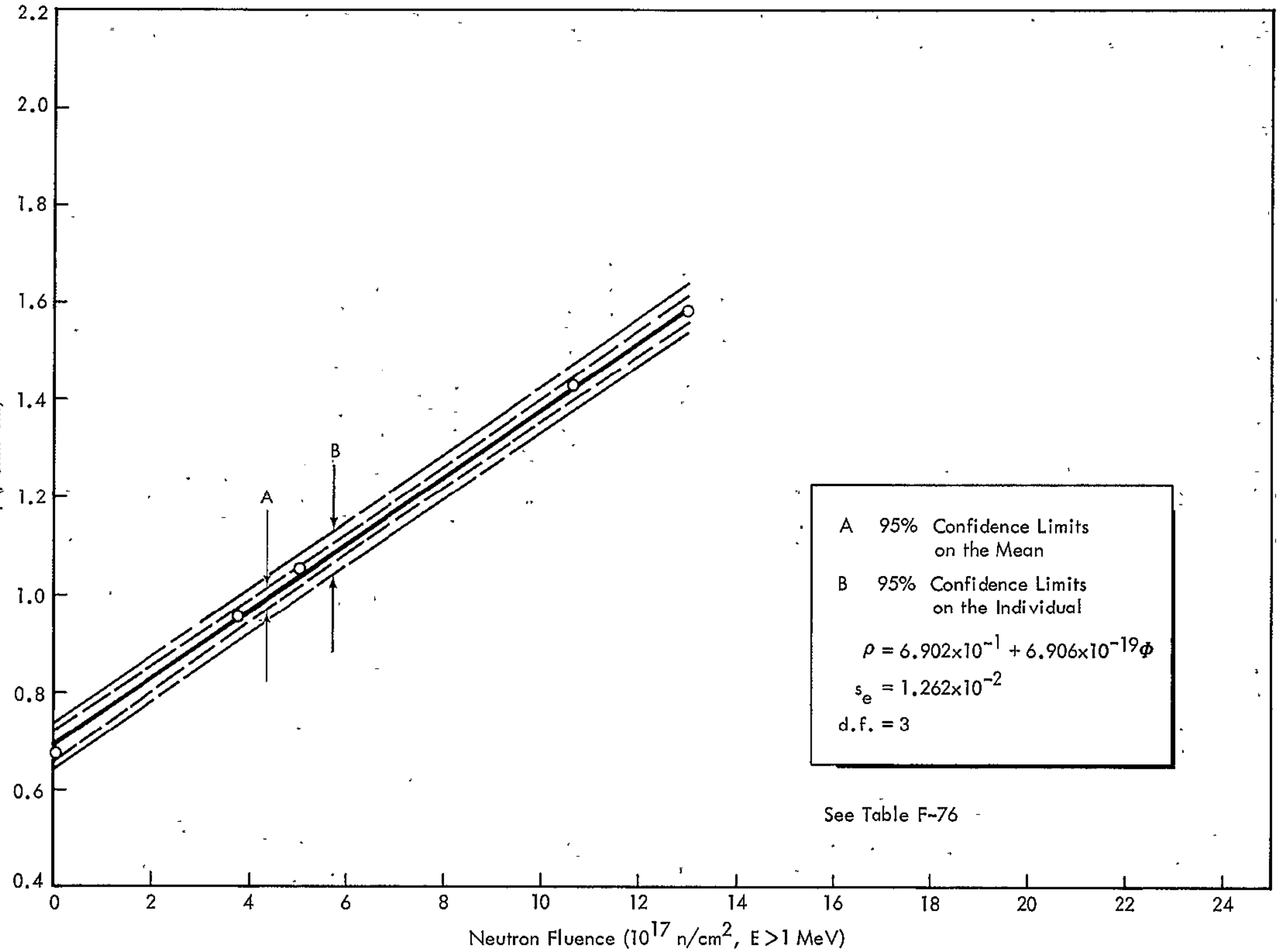

Figure 3-28 Electrical Resistivity of WANL Beryllium as a Function of Radiation Exposure at Zero Reactor Power

NPC 27,253

3.6.2.4 Titanium

The electrical resistivity of titanium as a function of temperature is presented in Figure 3-29. The data for all conditions, pre- and postirradiation and postirradiation-anneal, fall within 1% of each other. The total uncertainty in the change in electrical resistivity is approximately 2%; therefore, the changes in ρ resulting from the radiation levels of this experiment are questionable.

Figure 3-30 presents the calculated ρ values for titanium as a function of temperature for the GDFWD and NBS (Ref. 8) data. Over the temperature range of this experiment (80° to 300°K), the values calculated from the GDFWD data fall within 1% of the NBS data.

The electrical resistivity of titanium as a function of neutron fluence is presented in Figure 3-31. Again, the increase in electrical resistivity is a linear relationship with the neutron fluence.

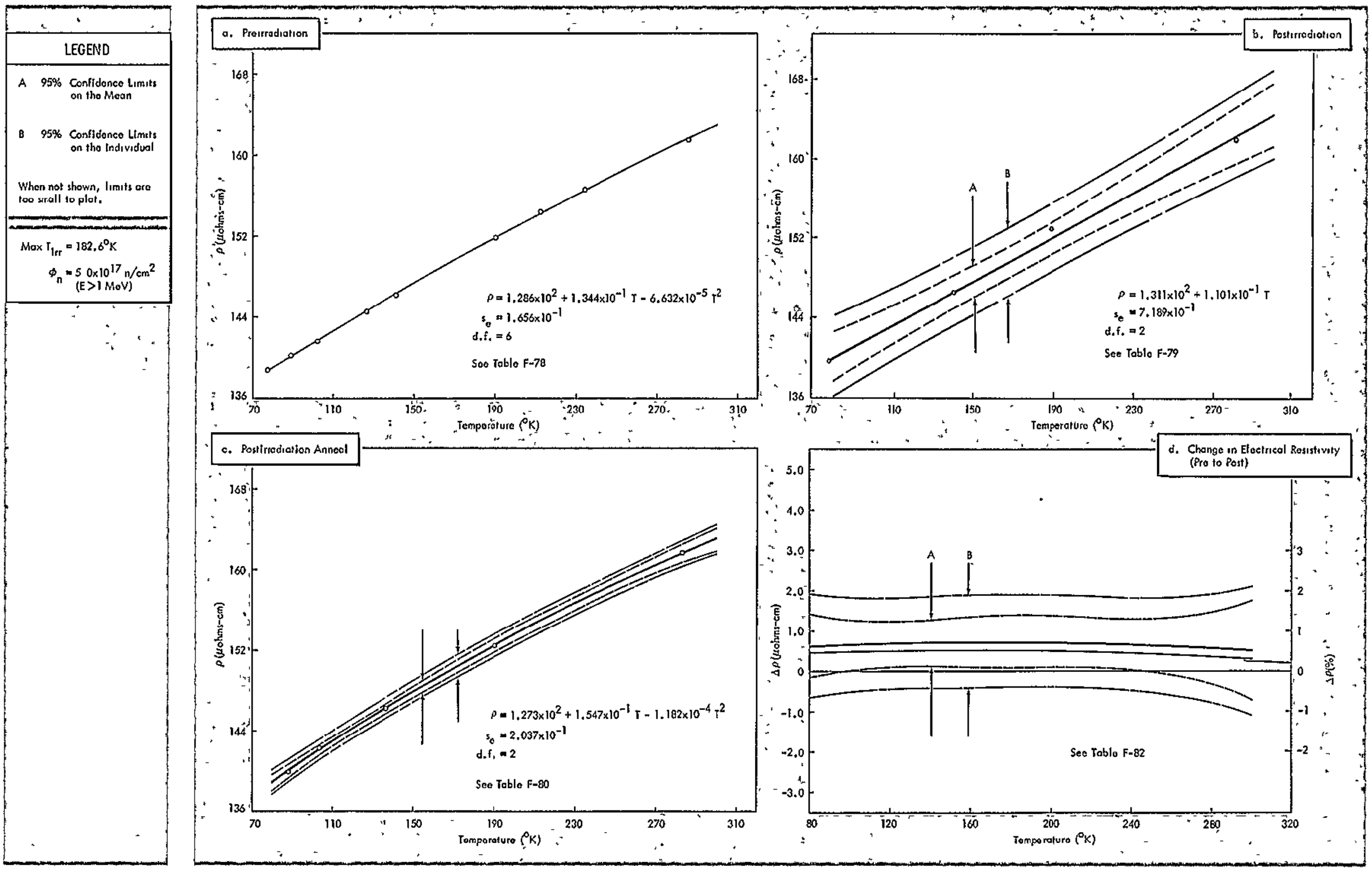

Figure 3-29 Electrical Resistivity of Titanium as a Function of Temperature

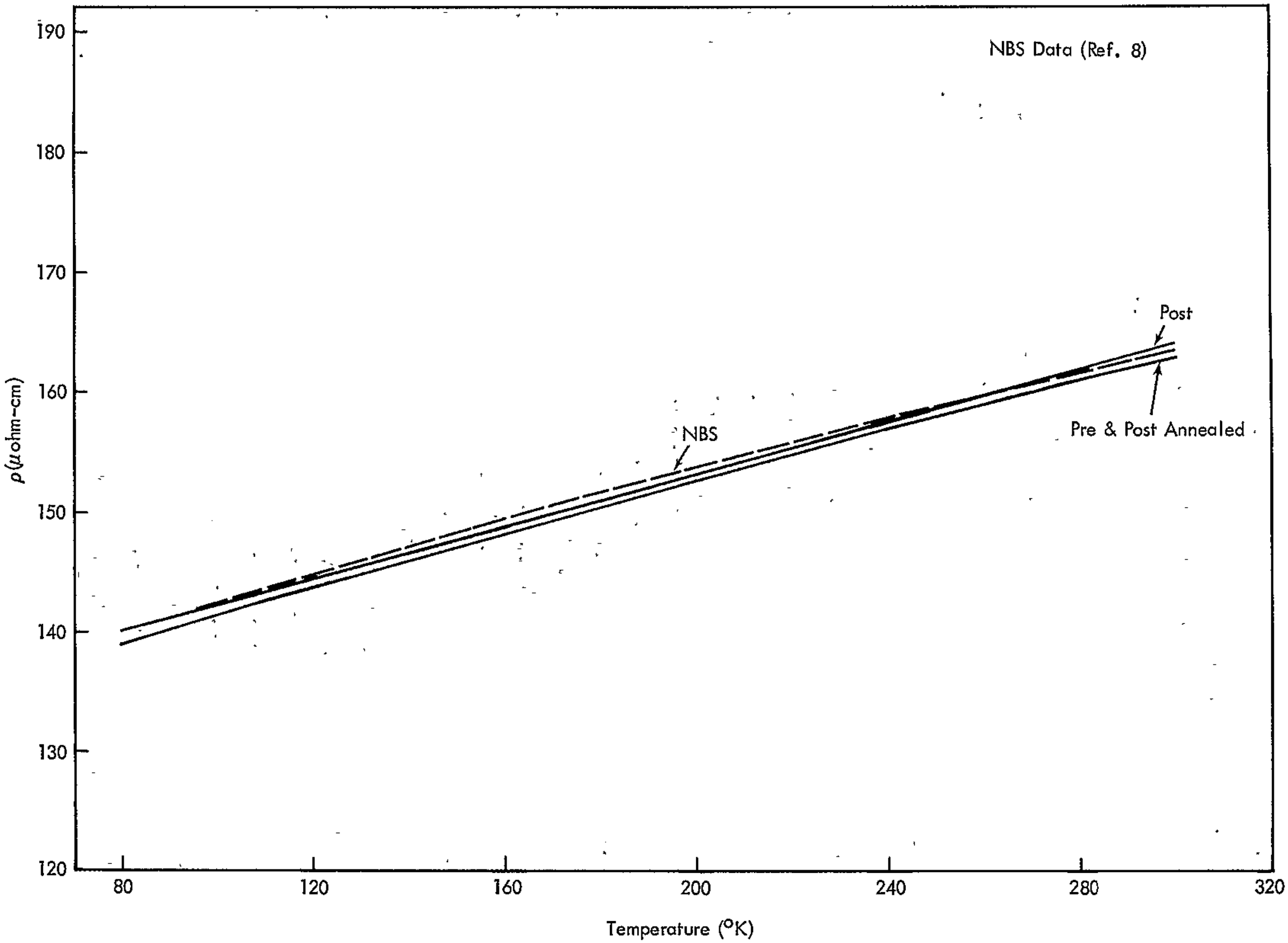

Figure 3-30 Comparison of GDFWD and NBS Electrical Resistivity for Titanium

NPC 27,255

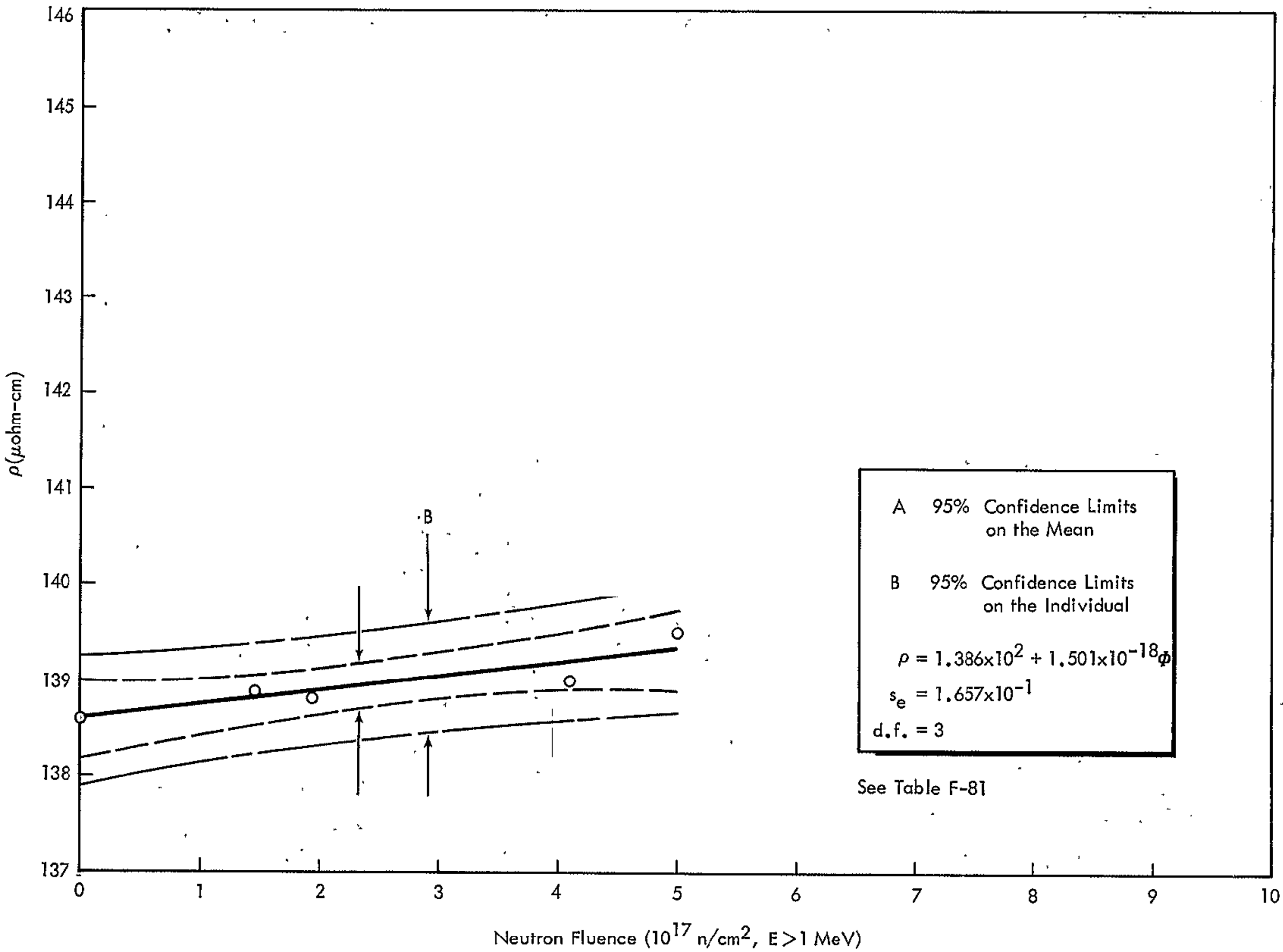

Figure 3-31 Electrical Resistivity of Titanium as a Function of Radiation Exposure at Zero Reactor Power

3.6.2.5 PO-3 Graphite

The electrical resistivity data for PO-3 graphite as a function of temperature are presented in Figure 3-32. The resistivity increased by approximately 52% at 80°K after exposure to the radiation levels of this experiment. Unlike the aluminum and beryllium specimens, the percent change in resistivity from preirradiation data to postirradiation data increased as the average specimen temperature increased. At 230°K the percent change in resistivity had increased to a maximum of 76.5% and then started decreasing to 72% at 290°K. After a room-temperature anneal, some recovery was evident, but unlike the aluminum and beryllium specimens, the recovery was not complete. At 80°K the specimen still had an increase of approximately 69%. This can be seen in Figure 3-33, which shows a comparison of the pre- and postirradiation and postirradiation-anneal mean curves and the NBS (Ref. 9) and preliminary BMI (Ref. 10) data.

The calculated ρ values for the preirradiation data agree with the NBS data within 3% at 80°K to 5% at 280°K. The BMI data is preliminary, but it falls between the GDFWD and NBS data. It should be noted, again, that the NBS and BMI data were taken using the same specimen. This specimen was a spare for the GTR-21 test at GDFWD.

The electrical resistivity of graphite as a function of neutron fluence is presented in Figure 3-34. These data fit a

second order polynomial and the increase in electrical resistivity appears to reach a maximum around 8 x 10^{17} n/cm^2 (E > 1 MeV).

The results of the follow on test are presented in Figures 3-35 through 3-38. Figure 3-38 is a mean-curve plot of all of the individual test runs. During these tests, the electrical resistivity, at 80^{o}K, recovered to approximately 28% of its pre-irradiation value after average specimen temperatures of 470^{o}K were obtained.

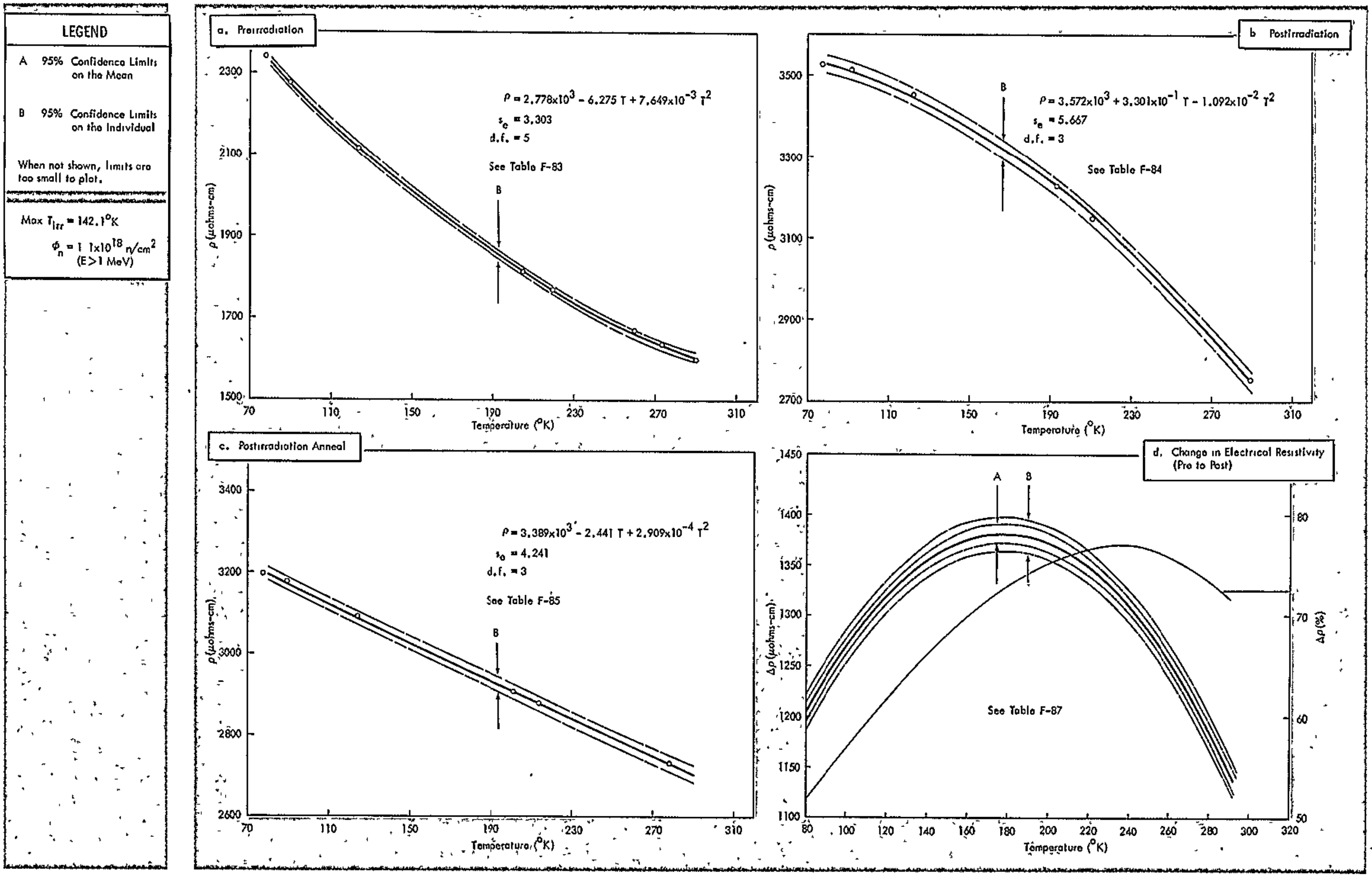

Figure 3-32 Electrical Resistivity of PO-3 Graphite as a Function of Temperature

NPC 27,257

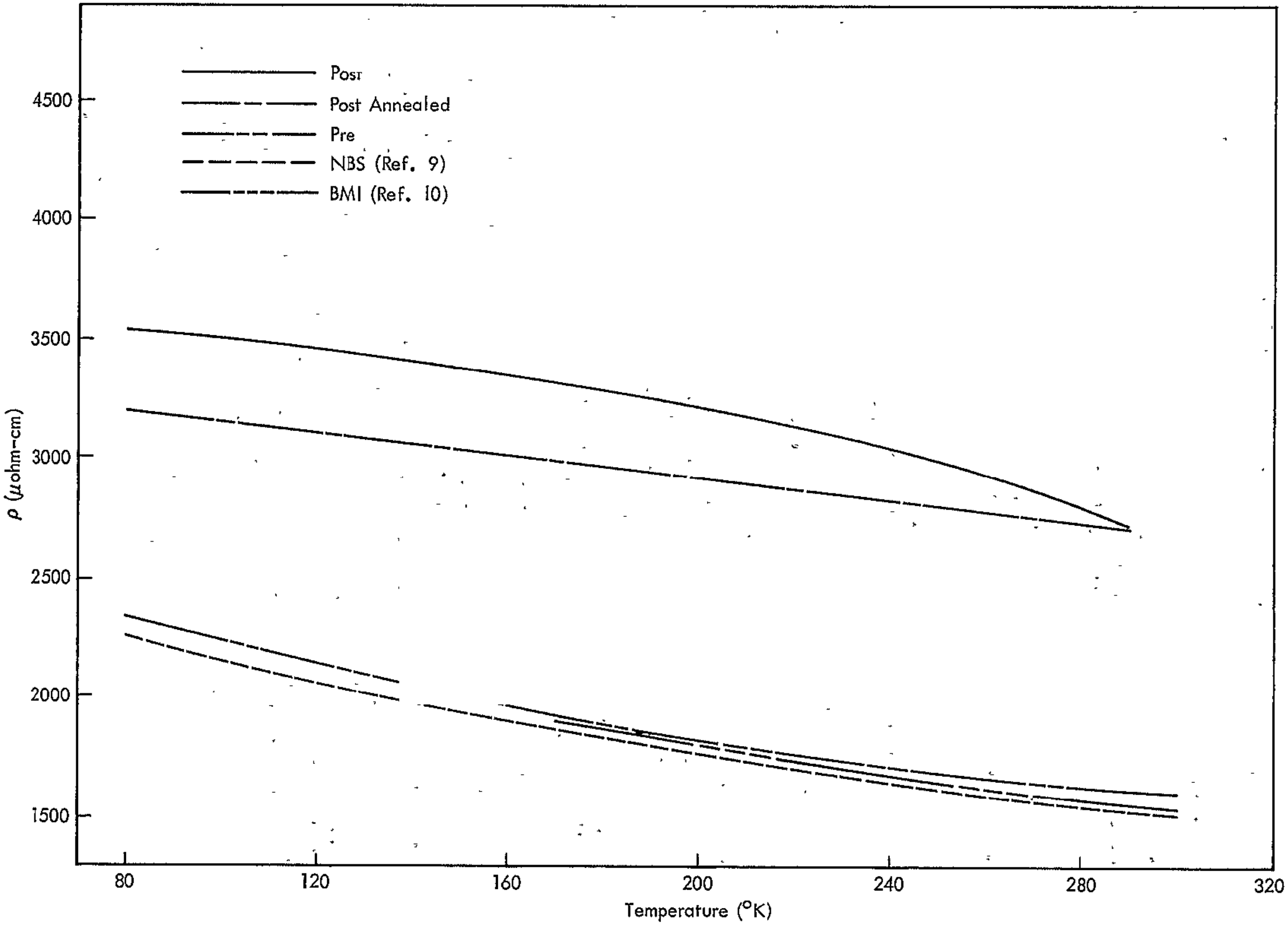

Figure 3-33 Comparison of GDFWD, NBS, and BMI Electrical Resistivity for PO-3 Graphite

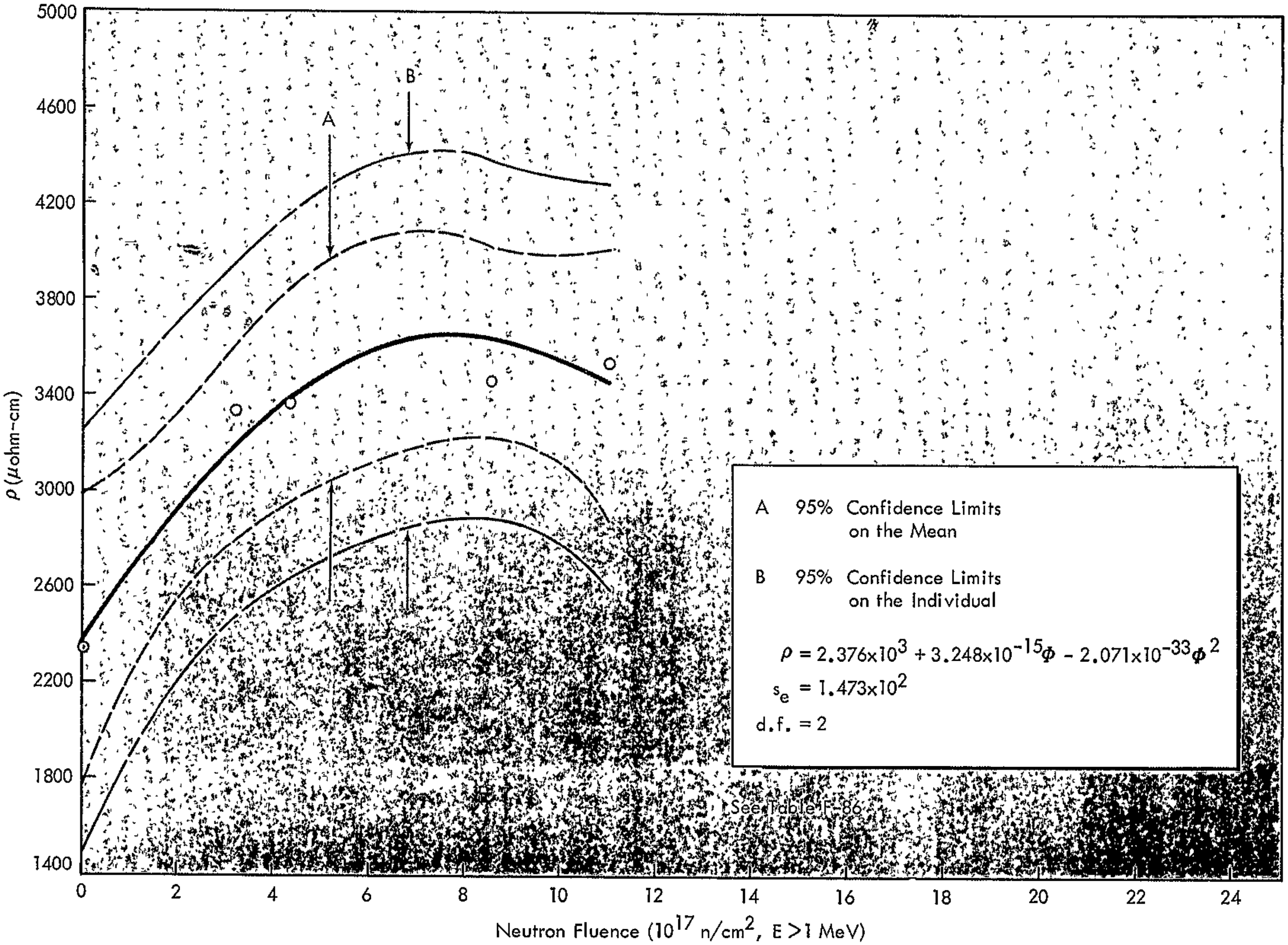

Figure 3-34 Electrical Resistivity of PO-3 Graphite as a Function of Radiation Exposure at Zero Reactor Power

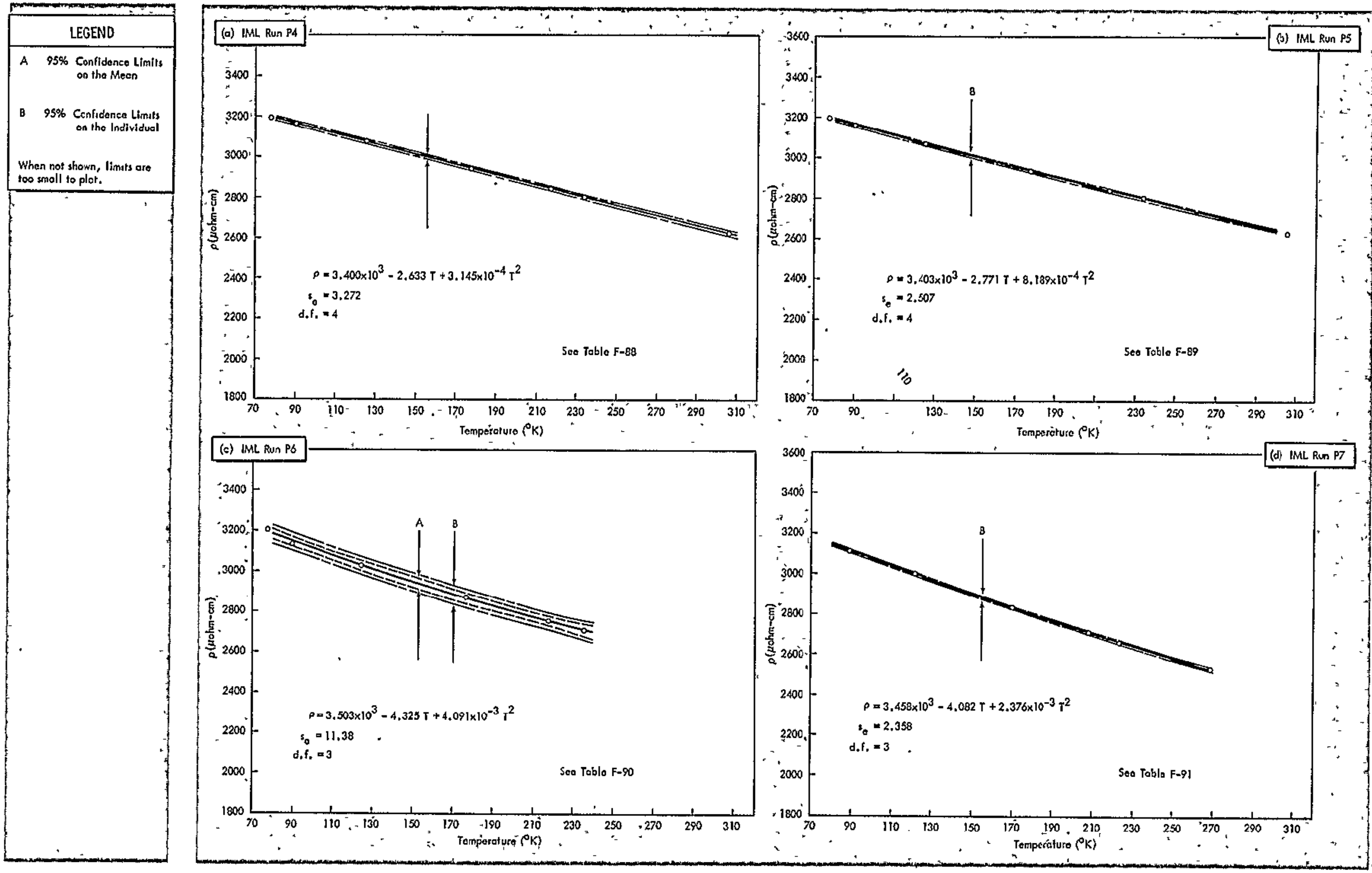

Figure 3-35 Electrical Resistivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs P4, P5, P6, and P7

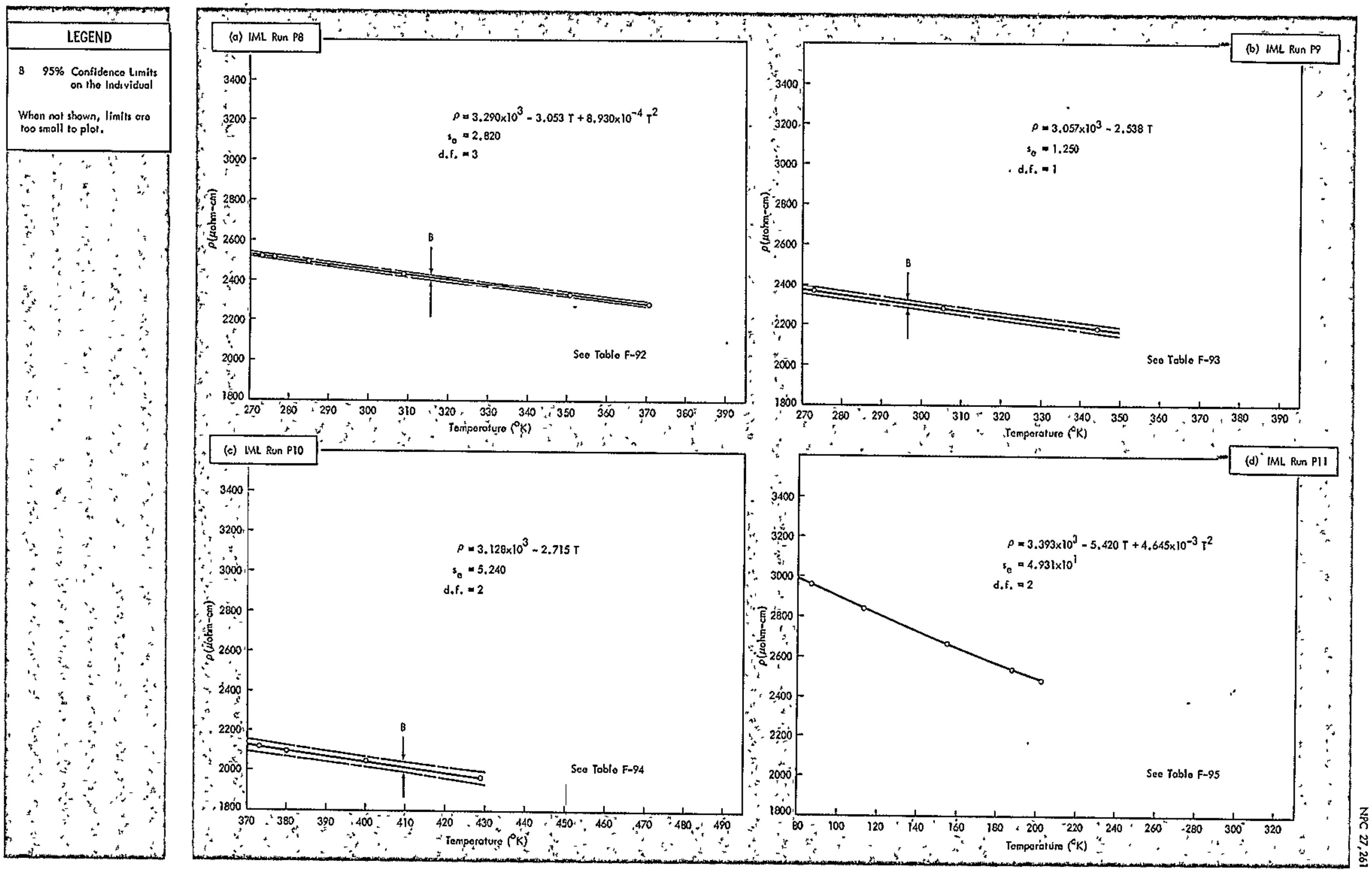

Figure 3-36 Electrical Resistivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs P8, P9, P10, and P11

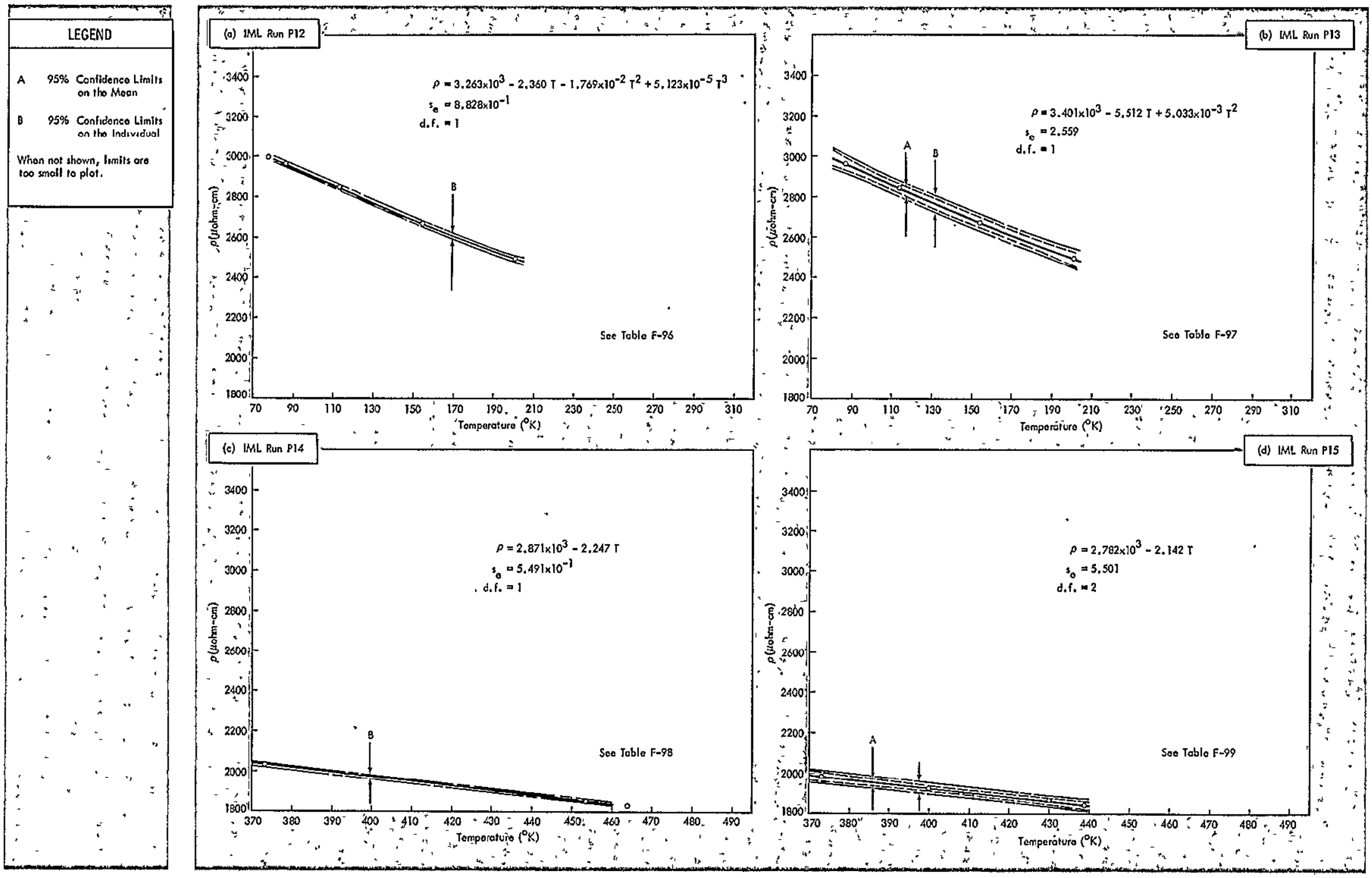

Figure 3-37 Electrical Resistivity of PO-3 Graphite as a Function of Temperature for Follow-on Test Runs P12, P13, P14, and P15

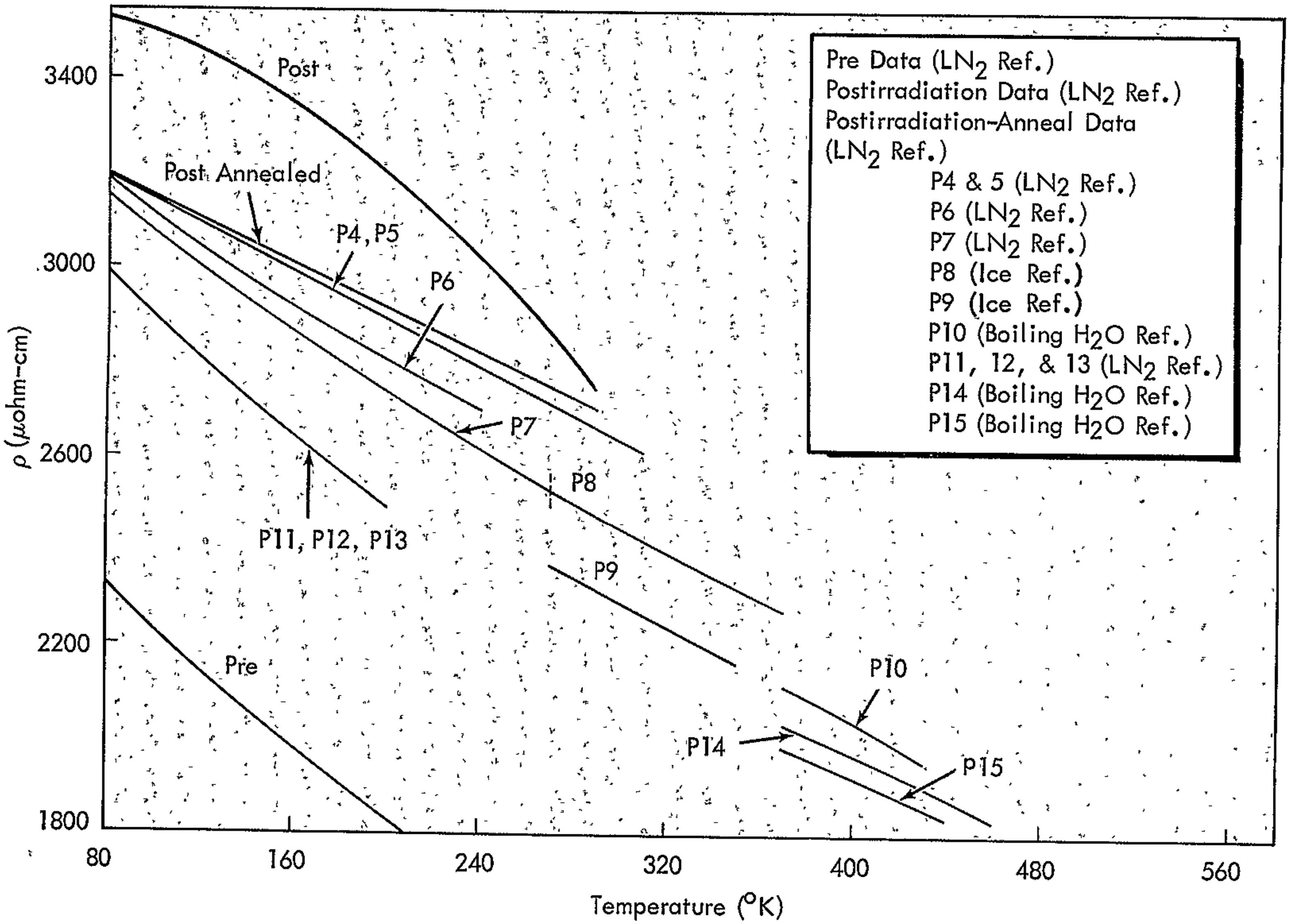

Figure 3-38 Electrical Resistivity of PO-3 Graphite as a Function of Temperature for All Follow-on Test Runs

3.6.3 Summary

In summary, it can be stated that all of the materials tested, with the exception of titanium, experienced increases in electrical resistivity after exposure to the radiation levels of this experiment. The WANL beryllium specimen exhibited the greatest radiation-induced changes, while the titanium experienced no detectable changes within the precision of measurement. Of those materials exhibiting a change, all except graphite exhibited less change as the temperature gradient across the specimen was increased. Graphite exhibited an increasing percent change in the value of resistivity as the temperature gradient increased. All specimens with the exception of graphite experienced complete recovery after a room-temperature anneal.

3.7 Wiedemann-Franz Law

One of the objectives of this experiment was to determine the applicability of the Wiedemann-Franz Law to the prediction of thermal conductivity by measurement of the electrical resistivity of each of the selected materials. The Wiedemann-Franz Law states that the thermal conductivity of a metal should be proportional to its electrical conductivity multiplied by its absolute temperature. This section is divided into two main parts: the first discusses the theory of the Wiedemann-Franz Law in general, and the second discusses the application of this law to the results of this experiment and future experiments where only electrical-resistivity measurements would be performed.

3.7.1 Theory of the Wiedemann-Franz Law

3.7.1.1 Electrical Resistivity

The observed resistance of crystalline solids to electron currents is a result of electron scattering by deviations from perfect periodicity. The simplest example of such a deviation is the point defect, i.e., the vacancy, the interstitial, or the impurity atom. If annealing effects (which change the defect concentration) are ignored, the electrical resistance due to defects is independent of temperature. Thus, one component of the electrical resistivity is a temperature-independent number, denoted by ρ_0, which is proportional to the defect concentration. Since the defect concentration produced by neutron irradiation is

usually proportional to the fluence, ρ_o can be expected to increase with time of exposure to neutron irradiation, the increase being proportional to the fluence (Ref. 11).

Thermal vibrations of the crystal lattice (phonons) are essentially time-dependent deviations from perfect periodicity and therefore give rise to another component of electrical resistivity. Since this thermal component exists even in crystals with no defects, it is often called the ideal resistivity and is denoted by ρ_i. The ideal resistivity is obviously an increasing function of temperature because the frequency of electron-phonon collisions depends on the number of thermal excitations present, i.e., on the thermal excitation energy or temperature. Because the ideal resistivity depends only on the electron and phonon distribution functions, the effect of radiation on $\rho_i(T)$ can be considered of second order.

The dependence of the electrical resistivity of most metals on temperature and radiation damage can therefore be summarized by

$$\rho = \rho_o + \rho_i$$

where ρ_o is the defect resistivity and ρ_i is the ideal resistivity. The term ρ_o increases in direct proportion to the dose received and, except for possible annealing effects, is independent of temperature. The term ρ_i is independent of the dose

received and is an increasing function of temperature. Since ρ_i is independent of dose, the change in ρ due to irradiation is the same as the change in ρ_o.

3.7.1.2 Thermal Conductivity

In a metallic crystal, heat is conducted in two distinct ways. The first, and usually the dominant mechanism, is the transport of energy by conduction electrons. The second mode is the transport of energy by phonons (coupled vibrations of the lattice). Thus, heat conduction can be expressed by the relationship

$$k = k_e + k_g$$

where k_e is the electronic thermal conductivity and k_g is the lattice thermal conductivity. In discussing the scattering processes which limit the flow of heat, it is more convenient to work with the thermal resistivity, which is defined as the reciprocal of the conductivity. Thus,

$$\frac{1}{W} = \frac{1}{W_e} + \frac{1}{W_g}$$

where the W's are the thermal resistivities.

Because W_e is the thermal resistivity due to conduction electron scattering, it is possible to refer to the previous discussion on electrical resistivity and immediately identify the resistivity mechanisms as electron-defect scattering and

electron-phonon scattering. Thus, in analogy with the expression for electrical resistivity, W_e is defined as

$$W_e = W_i + W_o$$

where W_i is the electron-phonon thermal resistivity and W_o is the electron-defect thermal resistivity. It should be noted, however, that although the same scattering processes contribute to both the thermal and the electrical resistivity, there is an important distinction in how they contribute. In treating electrical conduction the number of electrons flowing along electric field lines is important. Thus, the important quantity in a scattering interaction is the angle of scatter, which determines the direction of the scattered electron. In thermal conduction the energy carried by conduction electrons in the direction of the temperature gradient is important; therefore, both energy and direction changes due to scattering must be considered. If, however, the energy change is negligible compared to the initial kinetic energy of the electron, then the contributions to both the electrical and thermal resistivities depend only on the angle of scatter. For such "no energy loss" scattering processes, it is possible to show that the ratio of electrical resistivity to thermal resistivity is given by (Ref. 12)

$$\frac{\rho}{W} = LT$$

where L is the Lorenz number

$$L = 2.44 \times 10^{-8} \text{ watt-ohm}/{}^{o}K^{2}$$

This simple relation, known as the Wiedemann-Franz Law, is applicable to defect scattering at all temperatures. Thus,

$$W_o = \frac{\rho_o}{LT}$$

At low temperatures the analysis of the electron-phonon term W_i is complicated by the fact that conduction electrons, which have energies of the order of kT, can gain or lose energy through collisions with phonons that also have energies on the order of kT. Thus, at low temperatures it is possible for the electron-energy change to be quite large compared to the initial electron energy and the simple Wiedemann-Franz Law to relate W_i and ρ_i cannot be used.

If the preirradiation value of k_e is known, the radiation-induced change in k_e can be predicted simply from measurements of the electrical-resistivity change. To illustrate this, the Wiedemann-Franz Law can be used to obtain

$$\frac{1}{k_e} = W_e = W_i + W_i = W_i + \frac{\rho_o}{LT}$$

Since W_i is the electron-phonon thermal resistivity, its change due to irradiation can be ignored. Thus,

$$\frac{1}{k_e - \Delta k_e} = W_i + \frac{\rho_o + \Delta\rho}{LT}$$

where Δk_e is the change in electronic thermal conductivity and $\Delta\rho$ is the change in electrical resistivity. Thus,

$$\frac{1}{k_e - \Delta k_e} - \frac{1}{k_e} = \frac{\Delta\rho}{LT}$$

which can be solved for Δk_e

$$\Delta k_e = \frac{k_e}{1 + \frac{LT}{k_e \Delta\rho}}$$

As noted earlier the thermal conductivity of most metals is dominated by the electrical component at most temperatures. There are, however, some important special cases where the lattice component is significant. Consider, for example, a metal with a high defect concentration at a temperature low enough that the electrical resistivity is due almost entirely to defect scattering. In such a case the electronic component is

$$k_e \sim \frac{LT}{\rho_o}$$

which becomes smaller as ρ_o is increased, and approaches zero as $T \to 0$. Under such conditions the total thermal conductivity could easily be dominated by the lattice component.

The various components contributing to the lattice thermal resistivity are illustrated by the equation

$$\frac{1}{k_g} = W_g = W_{ge} + W_D + W_B + W_P + W_{PP}$$

where W_{ge} is the thermal resistivity due to phonon scattering by electrons, W_D is caused by scattering by dislocations, W_B i due to reflection at boundaries, W_P is due to point defect scattering, and W_{PP} is a result of phonon-phonon scattering. In metals the boundary resistance, which decreases in importance as T increases, is small compared to W_{ge} at low temperatures and is negligible compared to other components at high temperatures. The phonon-phonon term is negligible at low values of T, but increases in importance as T increases so that it often becomes the dominant contribution to k_g at high temperatures in very pure specimens. In the present experiment, however, the point-defect concentration seems to be such that W_{PP} is negligible compared to W_P for all temperatures of interest. Therefore, both W_B and W_{PP} are ignored and the relationship reduces to

$$W_g = W_{ge} + W_D + W_P$$

Theoretical investigations of phonon scattering have shown that at low temperatures both W_{ge} and W_D are proportional to T^{-2} and W_P is proportional to T (Ref. 12). Thus,

$$W_g = E/T^2 + D/T^2 + PT$$

where E, D, and P are constants characteristic of the specimen. The first term represents phonon-electron scattering and so can be assumed to be independent of the defect concentration, i.e., E is not affected by radiation. The parameter D could be radiation-sensitive through the pinning of dislocations by radiation-induced point defects and, possibly, through the formation of dislocation loops from radiation-induced vacancies. However, for the specimens and temperature range of interest, the effect of radiation on P is expected to be much more important. Thus, the change in lattice resistivity due to irradiation can be assumed to be

$$\Delta W_g = \Delta PT$$

where ΔP is the change in P and is proportional to the increase in point-defect concentration. Since the electrical resistivity change is also proportional to the change in point defect density, the change in P can be expressed as

$$\Delta P = P \frac{\Delta \rho}{\rho_o}$$

Therefore,

$$W_g + \Delta W_g = \frac{1}{k_g - \Delta k_g} = \frac{D + E}{T^2} + 1 + \frac{\Delta \rho}{\rho_o} \quad PT$$

and the change in the lattice conductivity is given by

$$\frac{1}{k_g - \Delta k_g} + \frac{1}{k_g} = \frac{\Delta\rho}{\rho_o} PT$$

$$\Delta k_g = \frac{k_g}{1 + \dfrac{\rho_o}{k_g\ \Delta\rho\ PT}}$$

Combining this with the previously derived expression for the change in electronic conductivity yields

$$\Delta k = \Delta k_e + \Delta k_g = \frac{k_e}{1 + \dfrac{LT}{k_e \Delta\rho}} + \frac{k_g}{1 + \dfrac{\rho_o}{k_g\ \Delta\rho\ PT}}$$

which gives the total change in thermal conductivity in terms of the preirradiation values of k_e, k_g, ρ_o, and P and the resistivity change $\Delta\rho$ due to irradiation.

3.7.1.3 Analysis of the NBS Beryllium Data

At very low temperatures the ideal electronic thermal resistivity is of the form

$$W_i \approx AT^n$$

where A is a constant and $n \approx 2$. Thus, at very low temperatures the thermal conductivity is of the form

$$k = \frac{1}{W_e} + \frac{1}{W_g} = \frac{1}{AT^n + \dfrac{\rho_o}{LT}} + \frac{1}{\dfrac{D + E}{T^2} + PT}$$

From their measurements of k and ρ in the range 4^o to 100^oK, Powell, Harden, and Gibson (Ref. 13) determined values for the

parameters ρ_o, D + E, and P for the same sample used in the radiation-effects test. They first determined ρ_o directly - it is simply the measured value of ρ as $T \rightarrow 0$. They then determined D + E and P and attempted to determine A by a curve-fit method with n = 2.5. Their results are

$$D + E = 4 \times 10^3$$

$$\rho_o = 1.01\ \mu\text{ohm-cm}$$

$$P = 0.01$$

in units such that k is given in watt/cm-^{o}K. The value of AT^n was too small in this temperature range for an accurate determination of A.

The data of Powell et al., along with measurements of the electrical-resistivity change $\Delta\rho$, were used to analyze the effect of radiation on k. The first step was the separation of the preirradiation lattice and electronic components. To do this it was assumed that the values of D + E and P as determined by Powell for the 4^o to 100^{o}K range hold also for the 80^o to 160^{o}K range. Implicit in this assumption is the additional assumption that the functional form of k, which is valid at low T, can be used up to 160^{o}K. This allowed the calculation of the lattice resistivity shown in Figure 3-39. The electronic component was then determined by subtraction from the measured preirradiation values of k, i.e. $k_e = k - k_g$. Next, the components of k_e were isolated

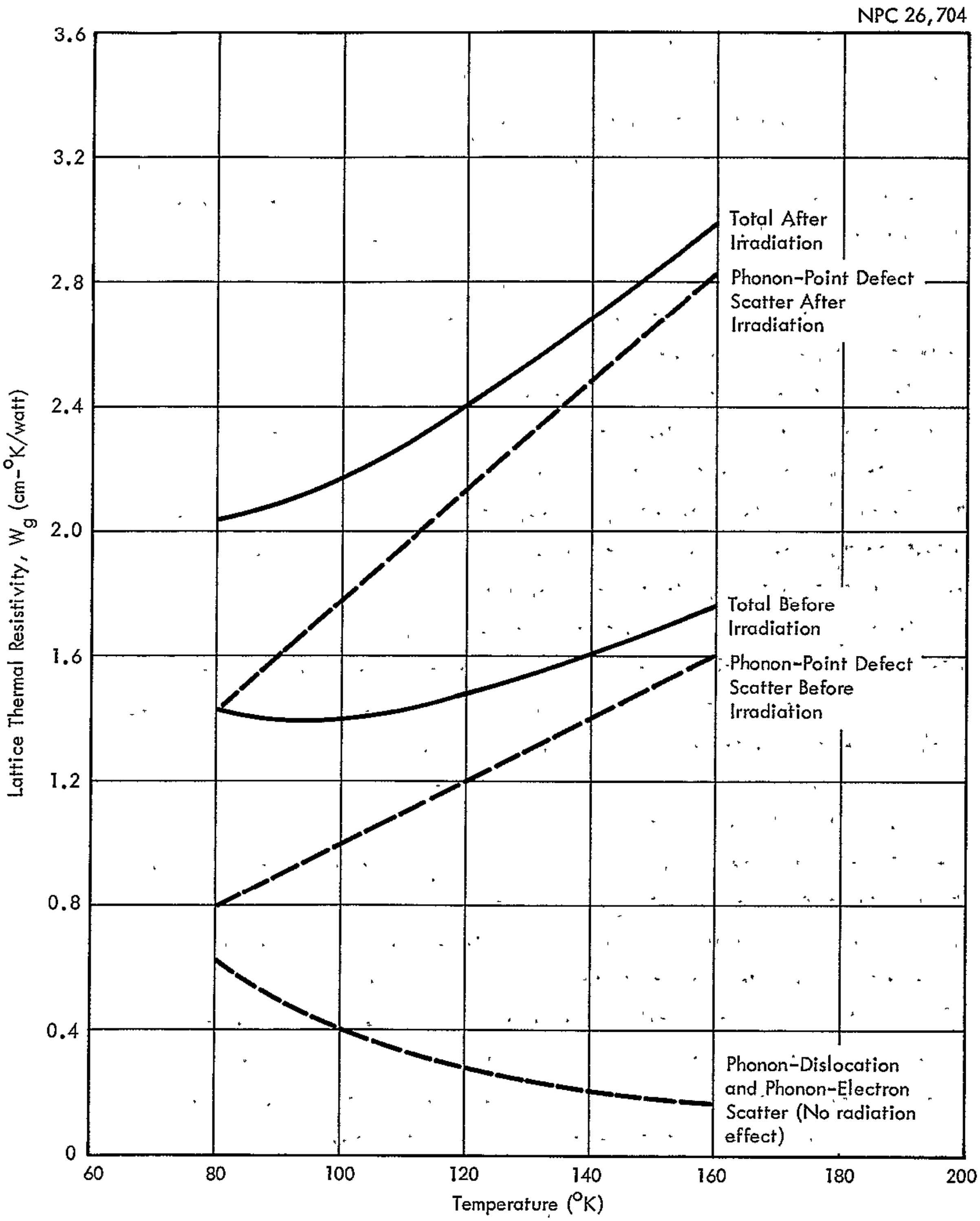

Figure 3-39 Lattice Thermal Resistivity of NBS Beryllium as a Function of Temperature

by calculating the defect part using the Wiedemann-Franz Law and Powell's value of ρ_o. The result is shown in Figure 3-40. The effects of radiation on k_e and k_g are also shown in Figures 3-39 and 3-40. These were obtained from the formulas developed in the preceding section. Finally, in Figure 3-41 the measured value of k after irradiation is compared with the prediction described above. The agreement is good, considering the uncertainty associated with the extrapolation of Powell's data to the temperature range of interest.

It can be concluded that the observed changes are consistent with Powell's data and with accepted theories of thermal and electrical conduction. It can also be concluded that the lattice conductivity and its change due to irradiation are too large to ignore. Even if the lattice component is regarded as completely unknown, a straightforward comparison of the calculated change in k_e, which is the most accurate of the calculated quantities, with the observed change in k shows that there must be a significant change in the lattice component.

3.7.1.4 Analysis of WANL Beryllium Data

Although there are no low temperature data available on the specimen supplied by Westinghouse, some estimates of the various components of k have been made and these are found to be consistent with the pre- and postirradiation data. The first estimate is that the electron-defect resistivity ρ_o is 0.6 μohm-cm for the

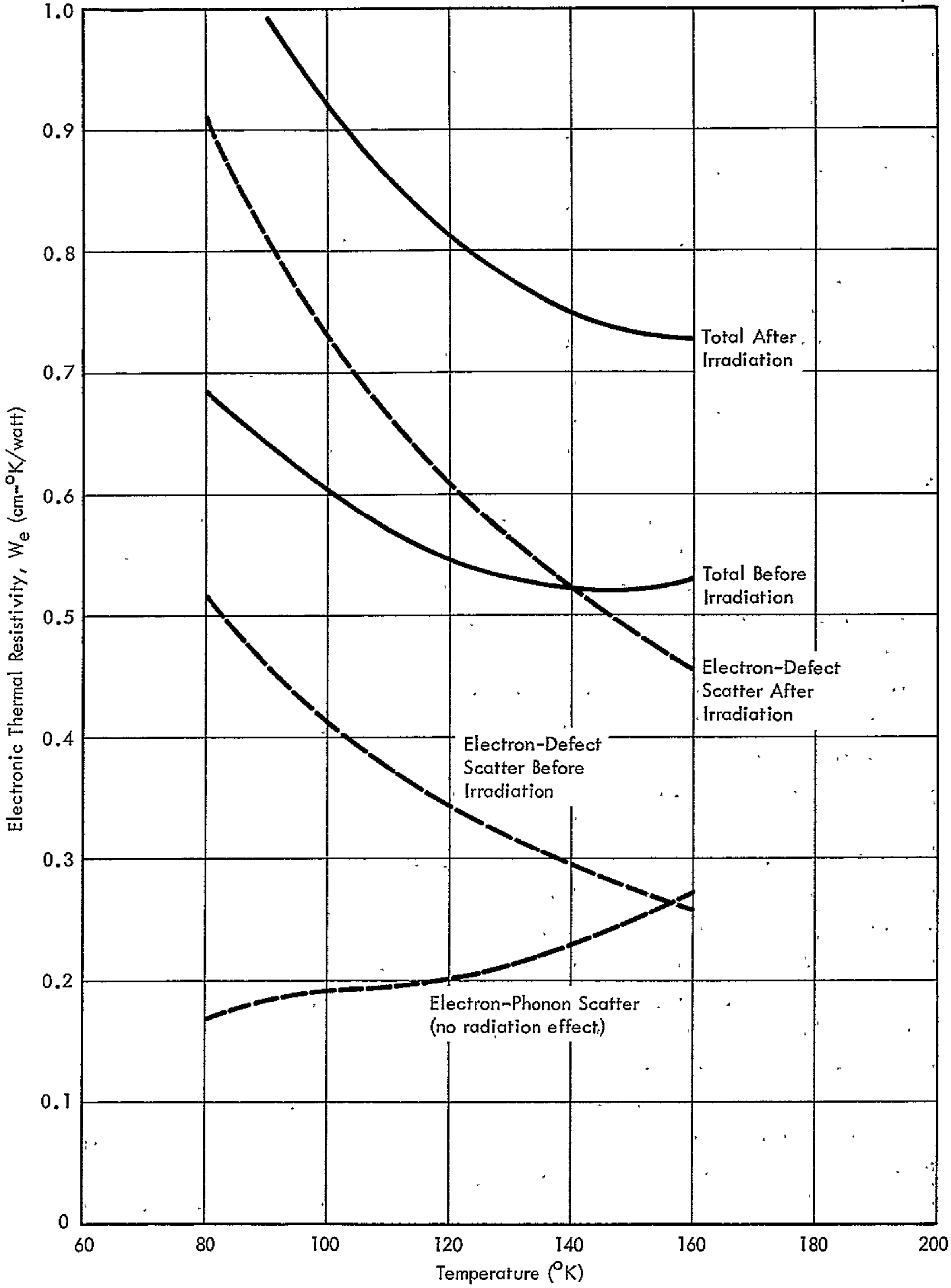

Figure 3-40 Electronic Thermal Resistivity of NBS Beryllium as a Function of Temperature

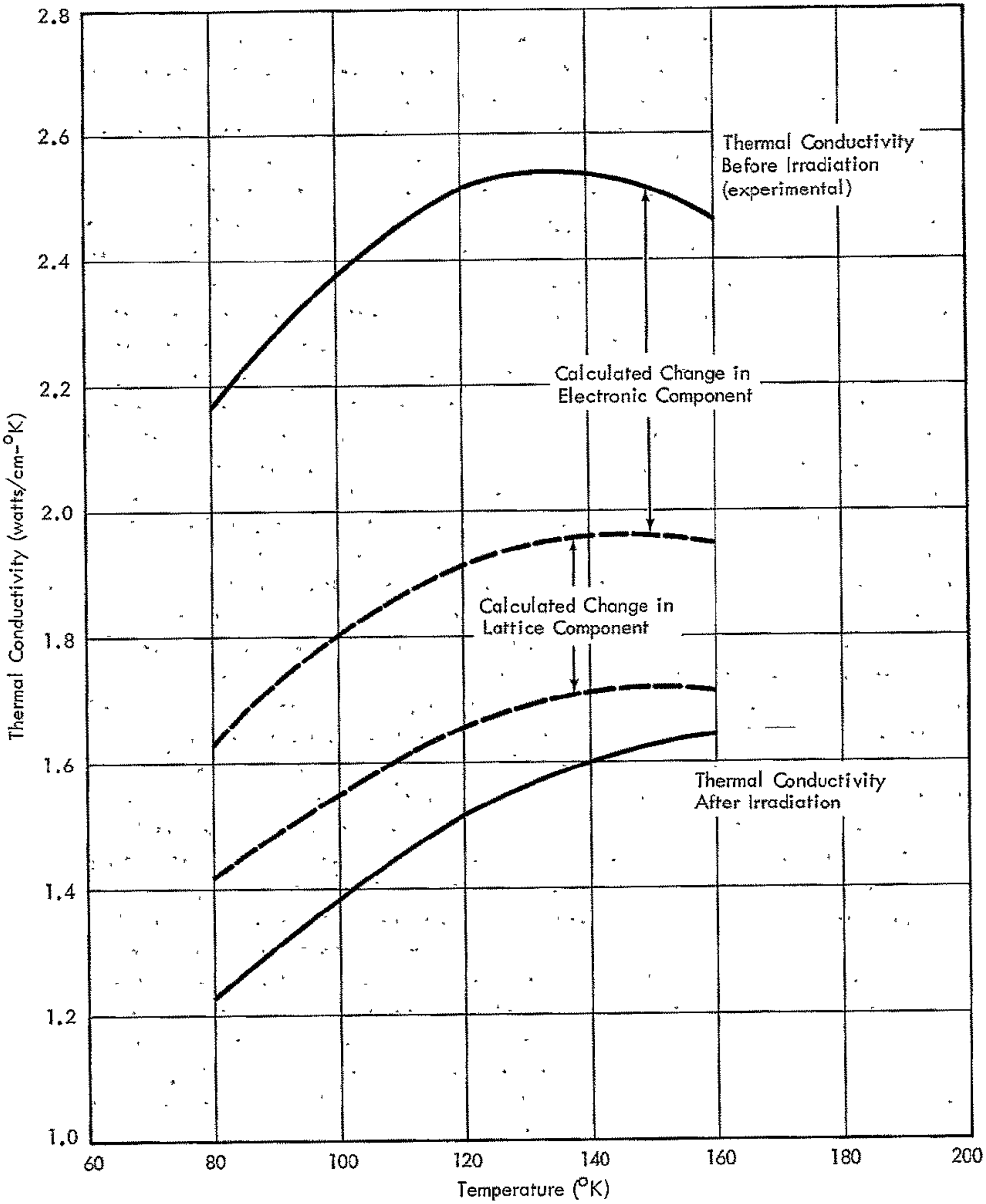

Figure 3-41 Thermal Conductivity of NBS Beryllium as a Function of Temperature

WANL specimen; the value for the NBS specimen is 1.01 μohm-cm. This estimate is based on an extrapolation of the electrical resistivity data to T = 0. It is consistent with the fact that the WANL specimen has a lower electrical resistivity and a higher thermal conductivity than the NBS specimen. Since ρ_o is a measure of the defect concentration and the phonon-point defect parameter P is also proportional to the defect concentration,

$$P_{WANL} = \frac{\rho_{oWANL}}{\rho_{oNBS}} P_{NBS} = \frac{0.6}{1} \times 0.01 = 0.006$$

Because no other information was available on which to base an estimate, it was assumed that the phonon-disolocation and phonon-electron terms are the same in the NBS and WANL specimens. It should be pointed out, however, that the dislocation coefficient D is a function of the dislocation density, which depends critically on the method of preparation of the sample. Nevertheless the above mentioned values of ρ_o, P, and D + E were used to separate the components of the lattice and electronic thermal resistivities, just as was done for the NBS specimen. The results are shown in Figures 3-42 and 3-43. The radiation effect was calculated from measurements of $\Delta\rho$ as before. The final value of the thermal conductivity is compared with experiment in Figure 3-44. Again, agreement is good, indicating that the estimated breakdown into components is at least consistent with the

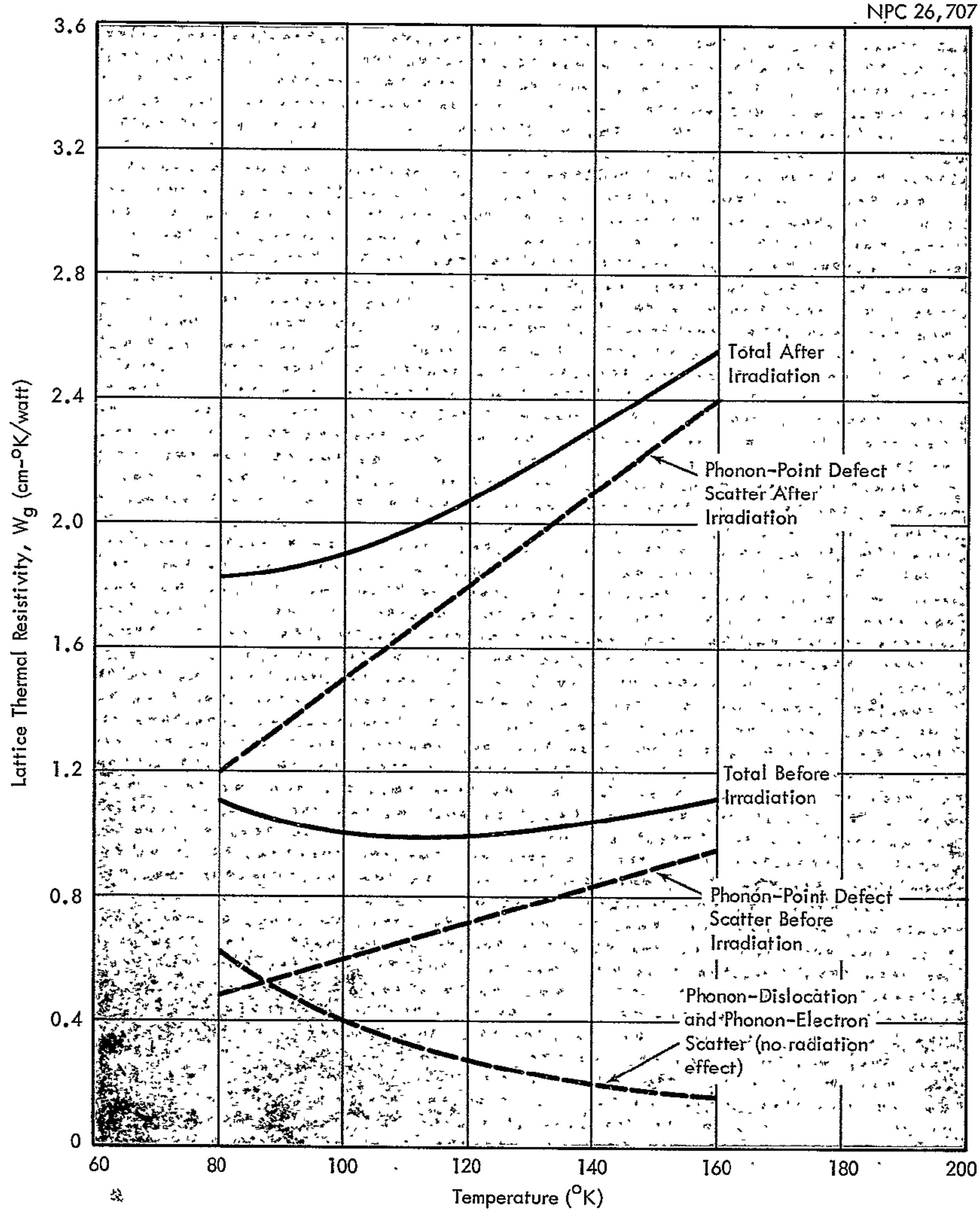

Figure 3-42 Lattice Thermal Resistivity of WANL Beryllium as a Function of Temperature

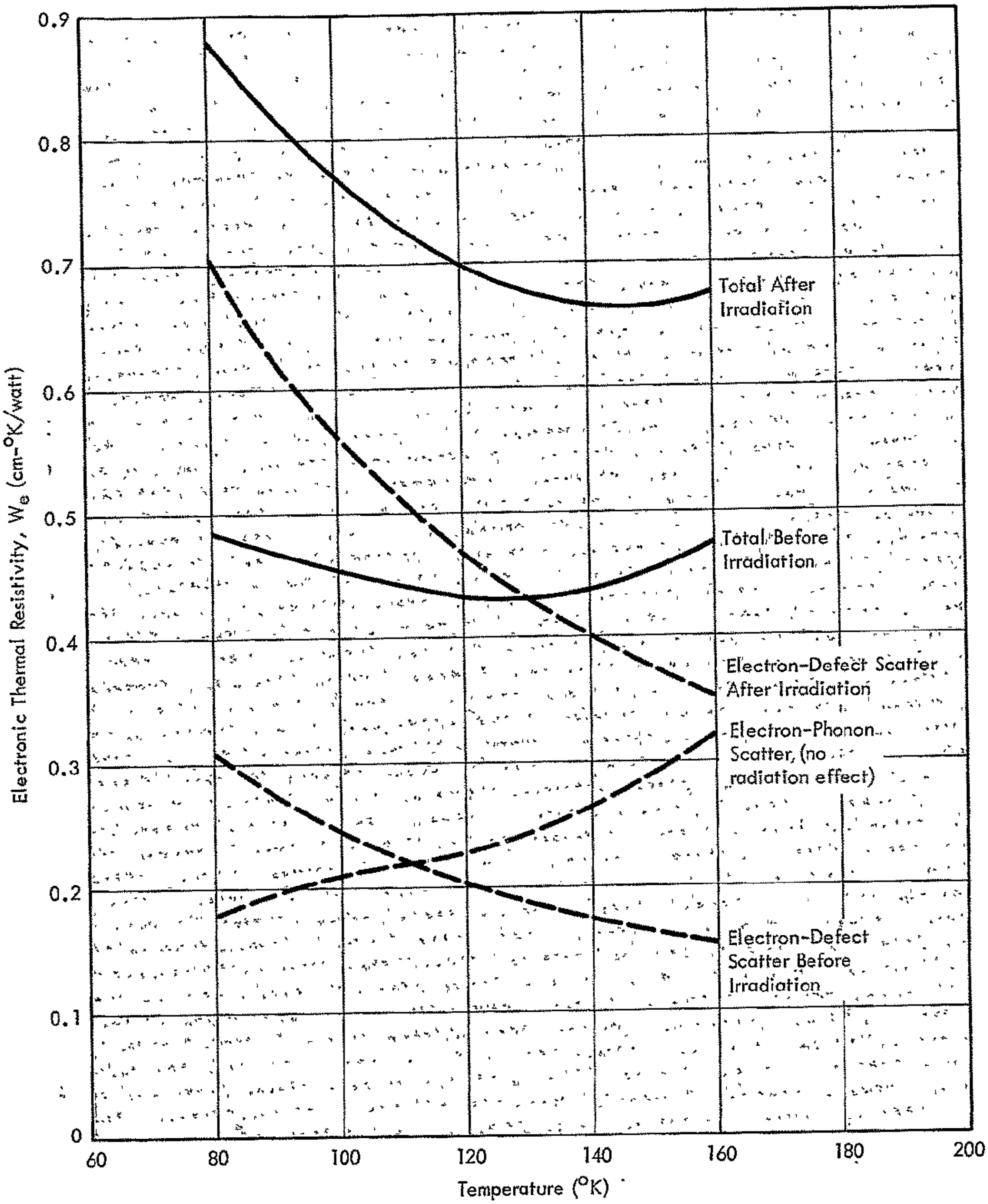

Figure 3-43 Electronic Thermal Resistivity of WANL Beryllium as a Function of Temperature

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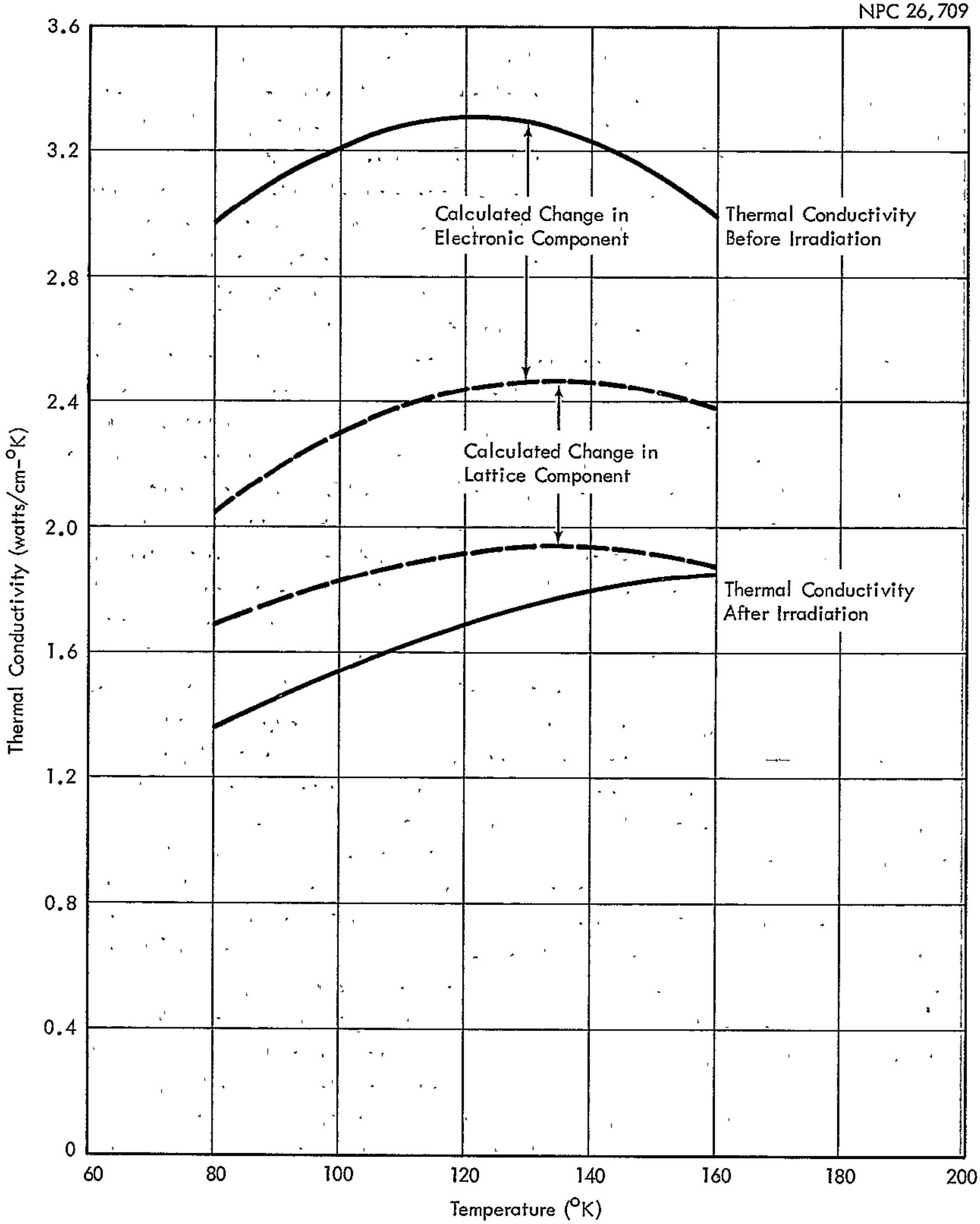

Figure 3-44 Thermal Conductivity of WANL Beryllium as a Function of Temperature

experiment. It is again evident that the lattice component and its change due to irradiation cannot be ignored.

3.7.1.5 Analysis of the Po-3 Graphite Data

A clue to the conduction mechanisms in graphite can be obtained by looking at the electrical-resistivity data and comparing it with the data on metals. It is noted that the electrical resistivity of graphite is something like a factor of 1000 greater than that of a metal at about 100°K. From this it is evident that electronic conduction is not very efficient in graphite and that the lattice component can be expected to dominate the thermal conductivity, at least at temperatures on the order of 100°K.

Analysis of the lattice conductivity of graphite is complicated by two facts: (1) the crystalline structure of graphite is highly anisotropic, and therefore the conductivity can be expected to be a sensitive function of the direction of the temperature gradient with respect to the crystal axes; and (2) unless special precautions are taken in the preparation of the specimen, its macroscopic structure is likely to be highly granular, and the lattice conductivity depends critically on the size and orientation of the grains.

For the reasons mentioned above, the kind of component-breakdown analysis for graphite cannot be performed as was done for beryllium. In fact, about all that can be said is that the

lattice component and that the change due to irradiation is caused by phonon scattering by radiation-induced point defects.

3.7.2 Application of the Wiedemann-Franz Law

Figures 3-45 through 3-54 and Tables F-48 through F-62 of Appendix F present "effective" Lorenz ratios and calculated thermal conductivities using the Wiedemann-Franz Law for all materials before and after irradiation over the applicable temperature range of this experiment. These effective Lorenz ratios were determined from the relationship

$$L_{eff} = \frac{k\rho}{T}$$

where L_{eff} is the effective Lorenz ratio for temperature T, k is the experimental value of thermal conductivity at temperature T, and ρ is the experimental value of resistivity at temperature T. The Wiedemann-Franz Law is not applicable for graphite, since lattice conductivity predominates and the interpretation of electrical resistivity is complex; however, the effective Lorenz ratios of graphite are presented along with those for aluminum, beryllium, and titanium.

Thermal conductivity values were calculated using the effective preirradiation Lorenz ratios, L_{pre}, and the Sommerfeld value, L_s, of the Lorenz ratio. k_L is determined from the relationship

$$k_L = \frac{L_{pre} T}{\rho_{post}}$$

where L_{pre} is the effective preirradiation Lorenz ratio at temperature T and ρ_{post} is the postirradiation electrical resistivity at temperature T. k_S is determined from the relationship

$$k_S = \frac{L_S \, T}{\rho_{post}}$$

where L_S is the Sommerfeld value of the Lorenz ratio, 2.44×10^{-8} watt-ohm/$^oK^2$, and ρ_{post} is the postirradiation electrical resistivity at temperature T.

3.7.2.1 Aluminum

The effective Lorenz ratios for aluminum are presented in Figure 3-45 and Tables F-48, F-49, and F-50 of Appendix F. The preirradiation values ranged from approximately 2.21 to 2.539×10^{-8} watt-ohm/$^oK^2$ over the temperature range 80° to 260°K and indicated the Sommerfeld value at approximately 220°K. The postirradiation values ranged from 2.253 to 2.606×10^{-8} watt-ohm/$^oK^2$ over the same temperature range, indicating the Sommerfeld value at approximately 190°K. There is an increase from preirradiation to postirradiation of approximately 2.0% at 80°K and approximately 2.6% at 260°K.

Figure 3-46 presents the thermal conductivity data calculated using the Wiedemann-Franz Law and a comparison plot with the measured values. For this specimen the values of k_L are within -2% of the measured value of k. The values of k_S deviate a maximum of +9% from the measured value of k. This indicates that if one uses the Sommerfeld value of L and the postirradiation value of to determine the postirradiation value of k, the result would be larger by approximately 9% than the measured value. For most engineering applications this would probably suffice. However, it is evident that if the preirradiation value of L_{eff} was determined and this value used in conjunction with the postirradiation value of ρ to determine the postirradiation value of k, a value very closely approximating the experimental value of k would be obtained.

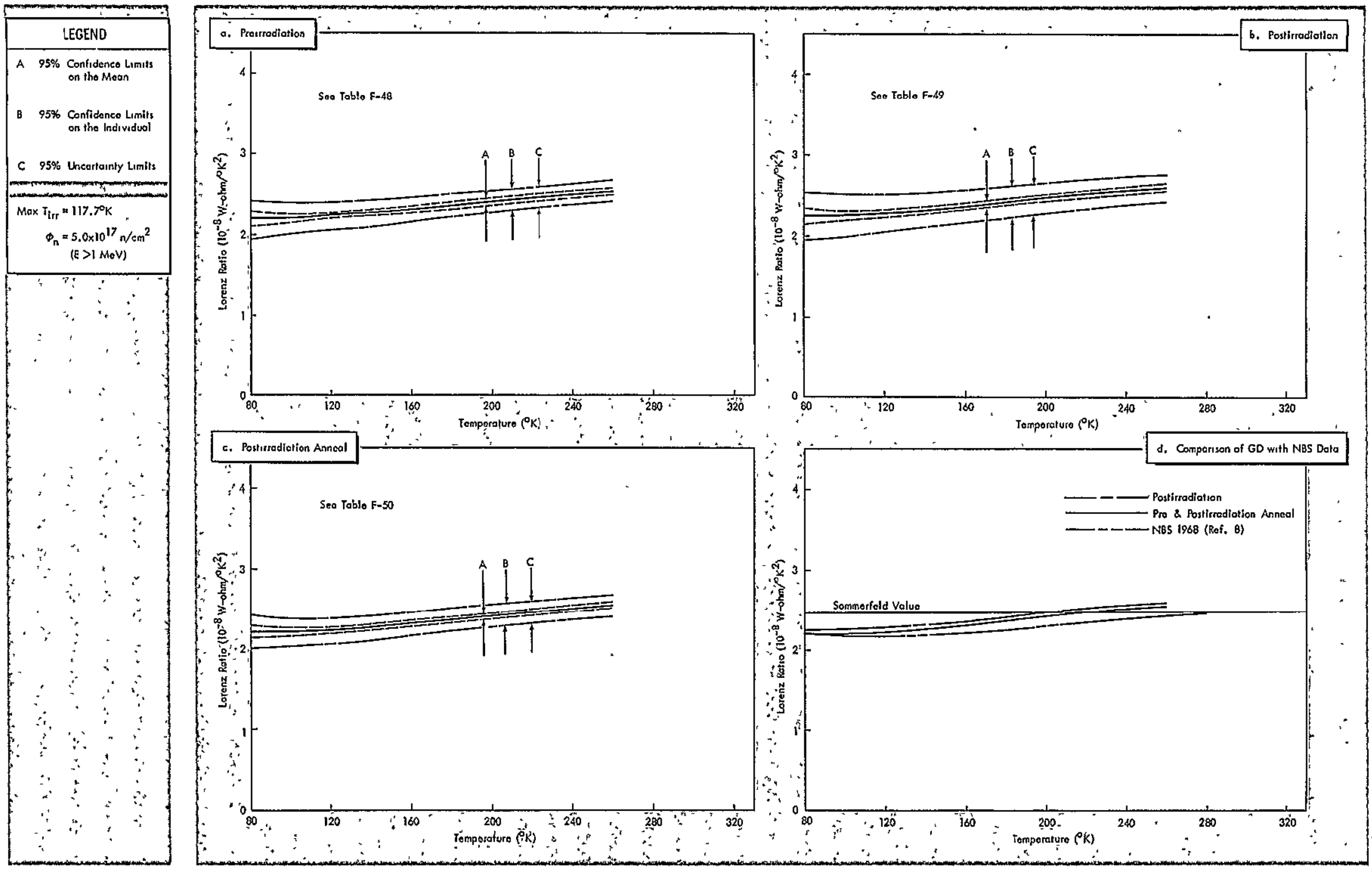

Figure 3-45 Effective Lorenz Ratio of Aluminum as a Function of Temperature

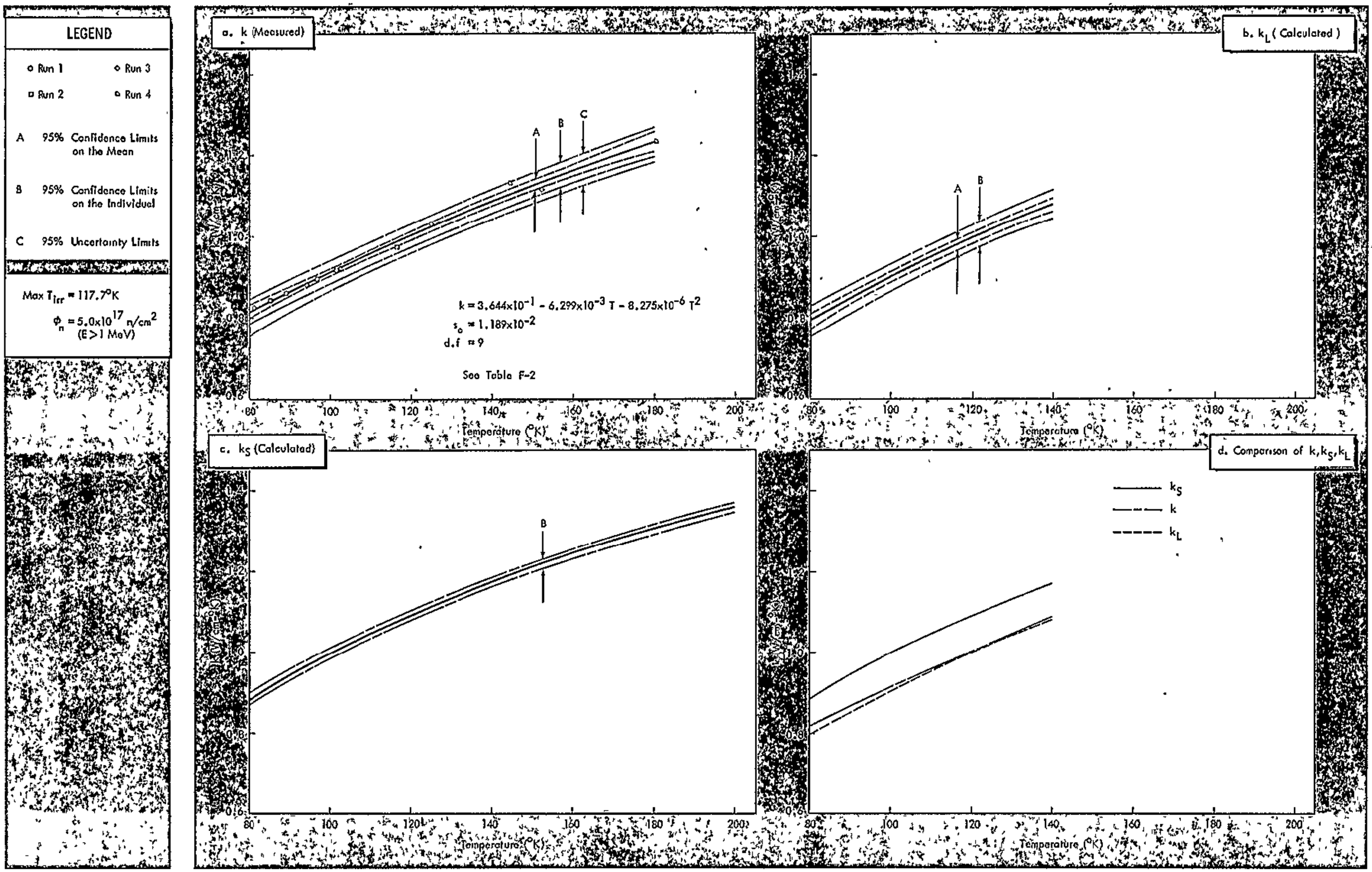

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Figure 3-46 Experimental and Calculated Thermal Conductivity of Aluminum as a Function of Temperature

3.7.2.2 NBS Beryllium

The effective Lorenz ratios for NBS beryllium are presented in Figure 3-47. The preirradiation values ranged from approximately 2.922 to 2.848 x 10^{-8} watt-ohm/$^{o}K^2$ over the temperature range from 80° to 160°K. The postirradiation values ranged from approximately 2.724 to 2.713 x 10^{-8} watt-ohm/$^{o}K^2$ over the temperature range from 80° to 140°K. Neither the pre- nor the postirradiation data indicated the Sommerfeld value over this range of temperatures. The postirradiation value of L_{eff} decreased by approximately 6.8% from the preirradiation value at 80°K, to approximately 3.4% at 140°K. This can be seen in Figure 3-47(d). The preirradiation data agree with the postirradiation-anneal data within 1% up to 140°K, and 2% up to 160°K. Again, this demonstrates the good precision or repeatibility of this experiment.

Figure 3-48 presents the thermal conductivity calculated using the Wiedemann-Franz Law and a comparison plot with the measured values. For this specimen the values of k_L are within +5.5% of the measured value of k from 80° to 140°K. The values of k_S are written -10.9% of the measured value of k from 80° to 140°K. Again, this illustrates that by using L_{eff} and postirradiation values, one can predict k with a much higher degree of accuracy than by using the Sommerfeld value of the Lorenz ratio.

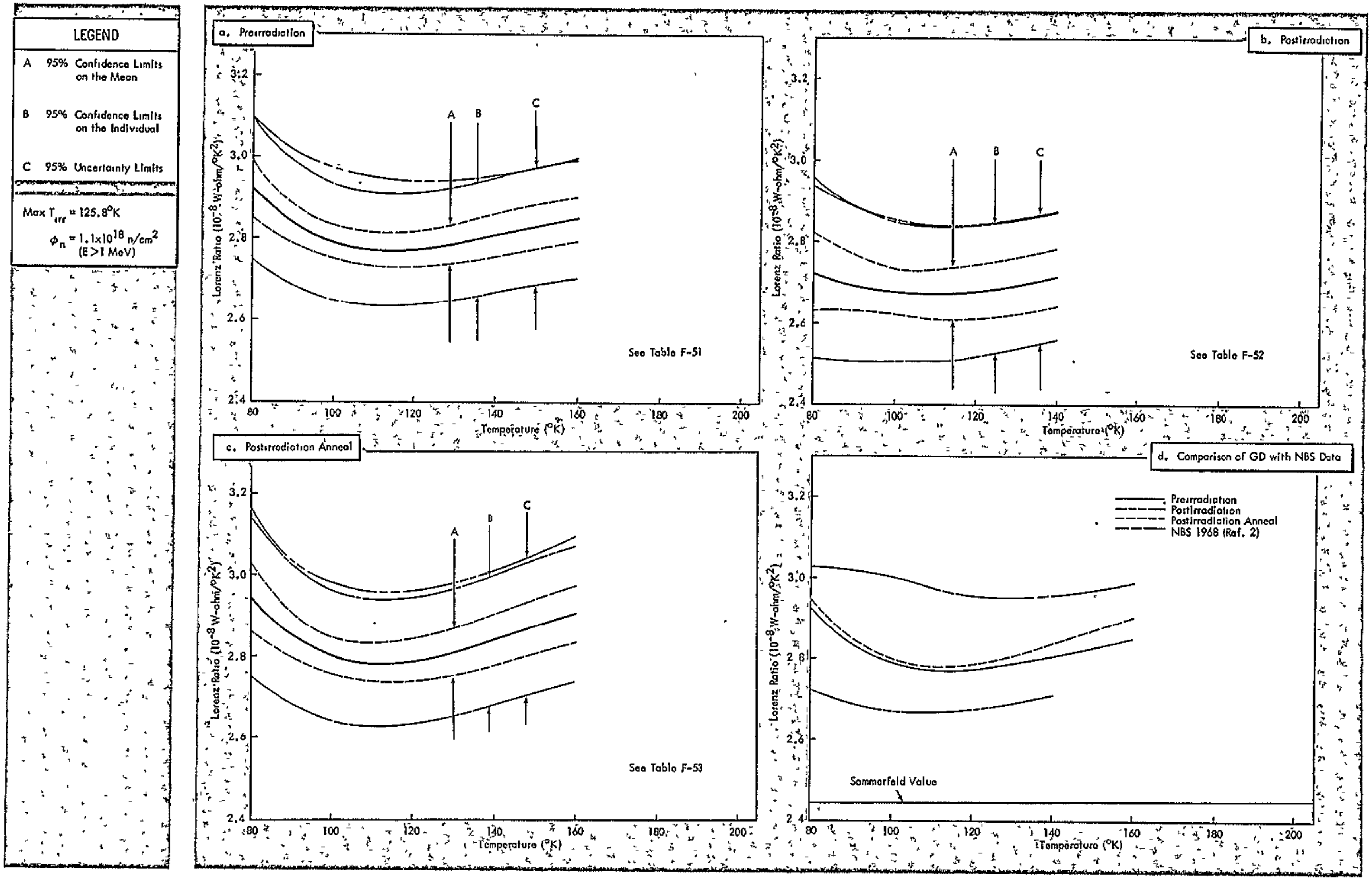

Figure 3-47 Effective Lorenz Ratio of NBS Beryllium as a Function of Temperature

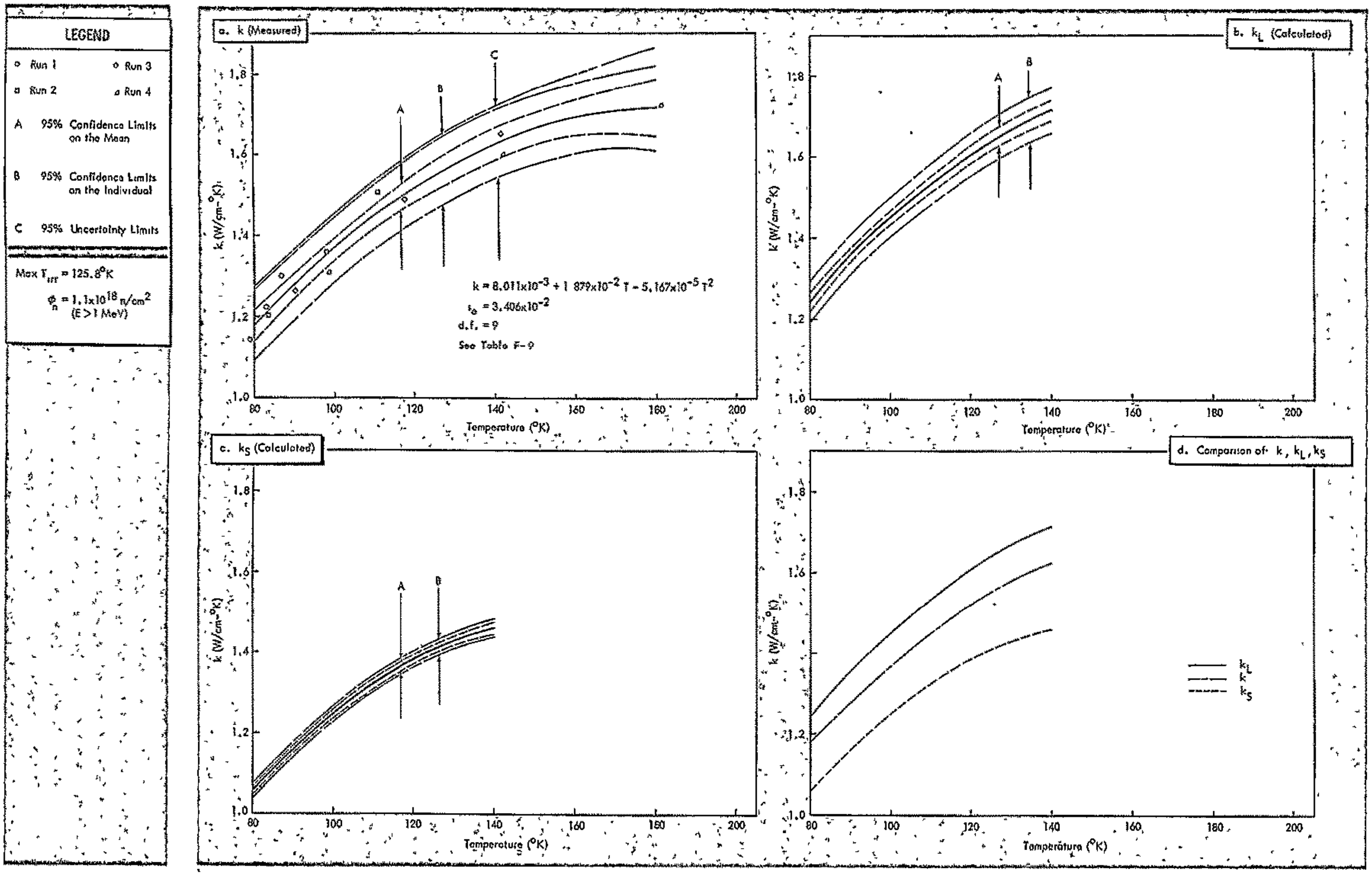

Figure 3-48 Experimental and Calculated Thermal Conductivity of NBS Beryllium as a Function of Temperature

3.7.2.3 WANL Beryllium

The effective Lorenz ratios for WANL beryllium are presented in Figure 3-49. Neither the pre- nor the postirradiation data indicated the Sommerfeld value over the temperature range of this experiment. The effective L increased from preirradiation to postirradiation, which is in direct opposition to the decrease noted for NBS beryllium.

Figure 3-50 presents the thermal conductivity data calculated using the Wiedemann-Franz Law and a comparison plot with the measured values. For this specimen the values of k_L deviate from the measured value of k by +2.3% at 80^o to a maximum of -5.8% at 105^oK. The values of k_S deviate by -2.3% at 80^oK to a maximum of 9.6% at 105^oK.

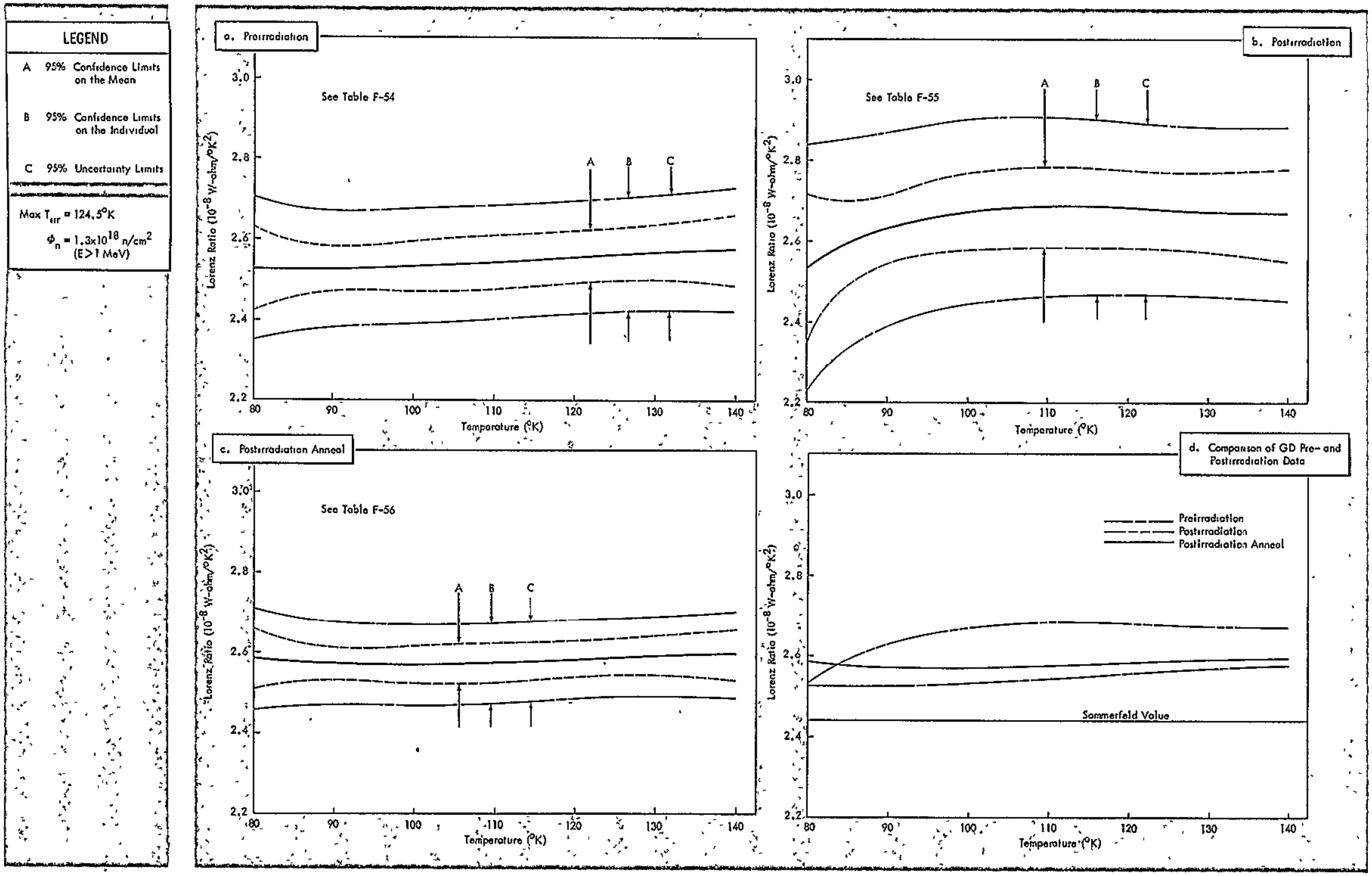

Figure 3-49 Effective Lorenz Ratio of WANL Beryllium as a Function of Temperature

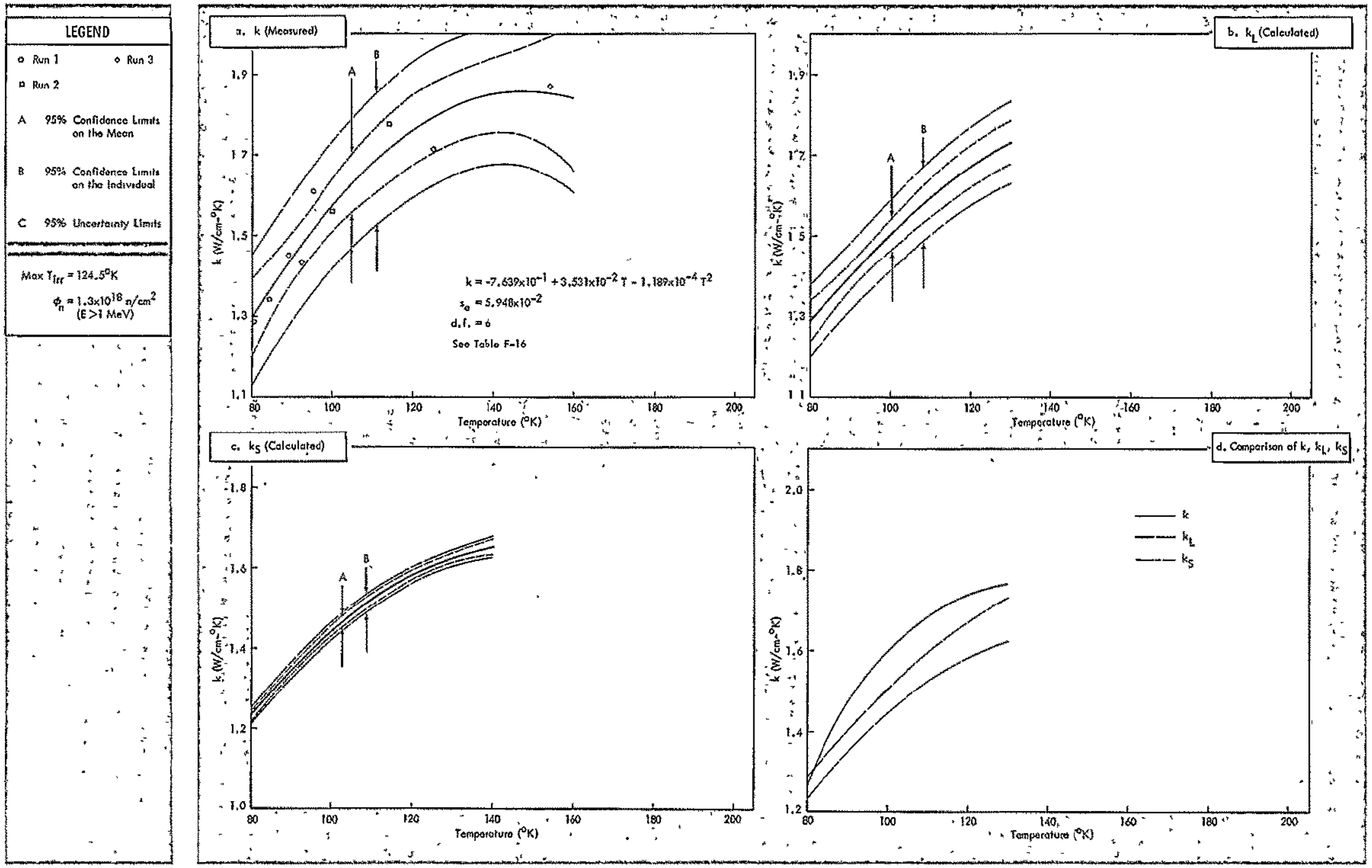

Figure 3-50 Experimental and Calculated Thermal Conductivity of WANL Beryllium as a Function of Temperature

3.7.2.4 Titanium

The effective Lorenz ratios for titanium are presented in Figure 3-51. The effective Lorenz number ranges from 8.421 to 5.001 x 10^{-8} watt-ohm/$^{o}K^{2}$ over the temperature range from 80^{o} to 300^{o}K. Since no significant change in thermal conductivity or resistivity can be attributed to radiation, the preirradiation and postirradiation values of L follow the same curve and deviate from each other by a maximum of 2.7%. What is of importance in this plot is the magnitude of the effective Lorenz number with respect to the Sommerfeld value.

Figure 3-52 presents the thermal-conductivity data calculated using the Wiedemann-Franz Law and a comparison plot with the measured values. Since there was no significant change in k or ρ after exposure to the radiation levels of this experiment, k_L and the measured value of k follow the same curve with a maximum deviation of approximately 1.6%. The significant thing about this plot is that it illustrates the possible error involved in calculating k if one assumes that the Sommerfeld value is valid at these temperatures. Such an assumption leads to a value of k which deviates from the measured value by -70.1% at 80^{o}K.

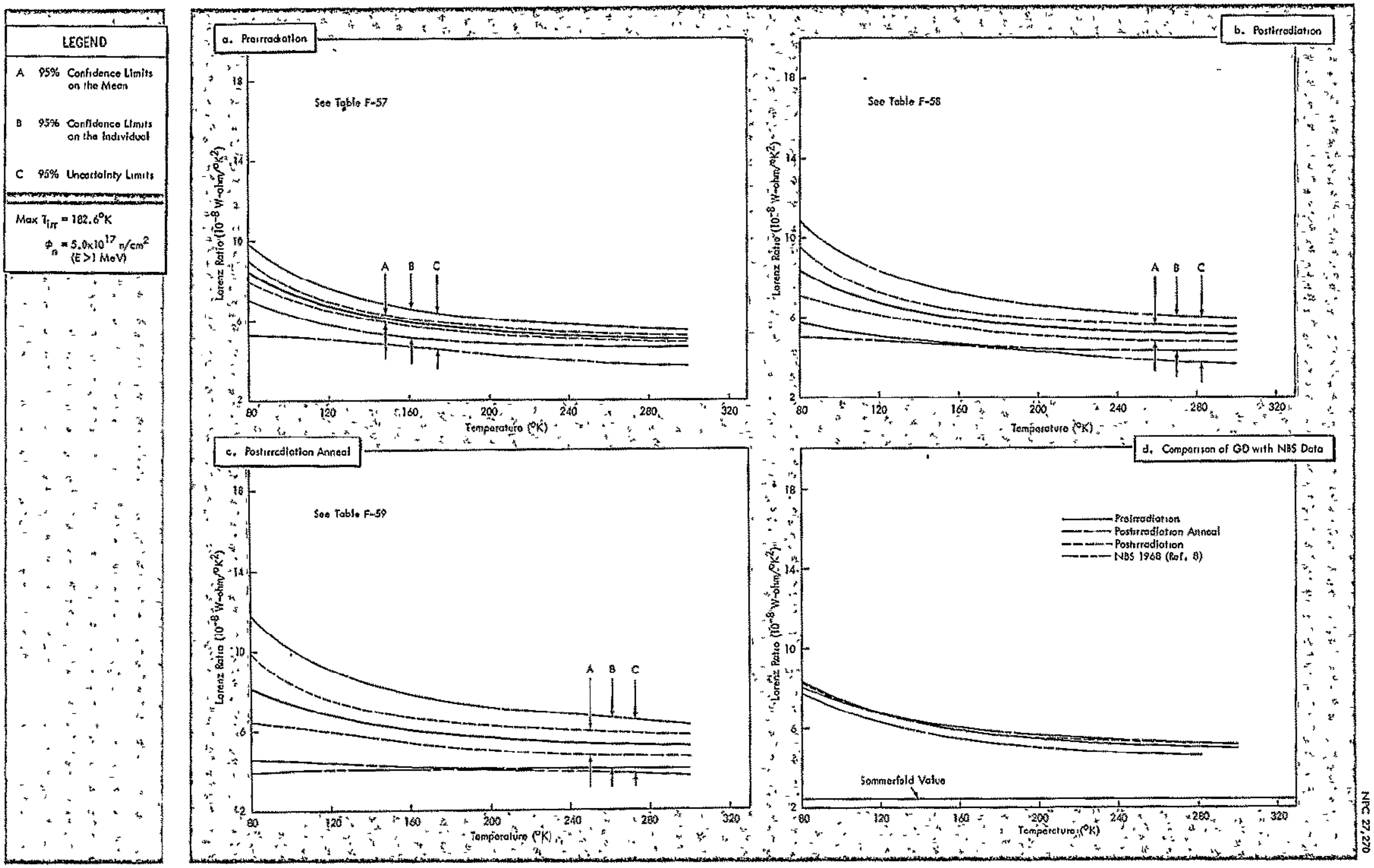

Figure 3-51 Effective Lorenz Ratio of Titanium as a Function of Temperature

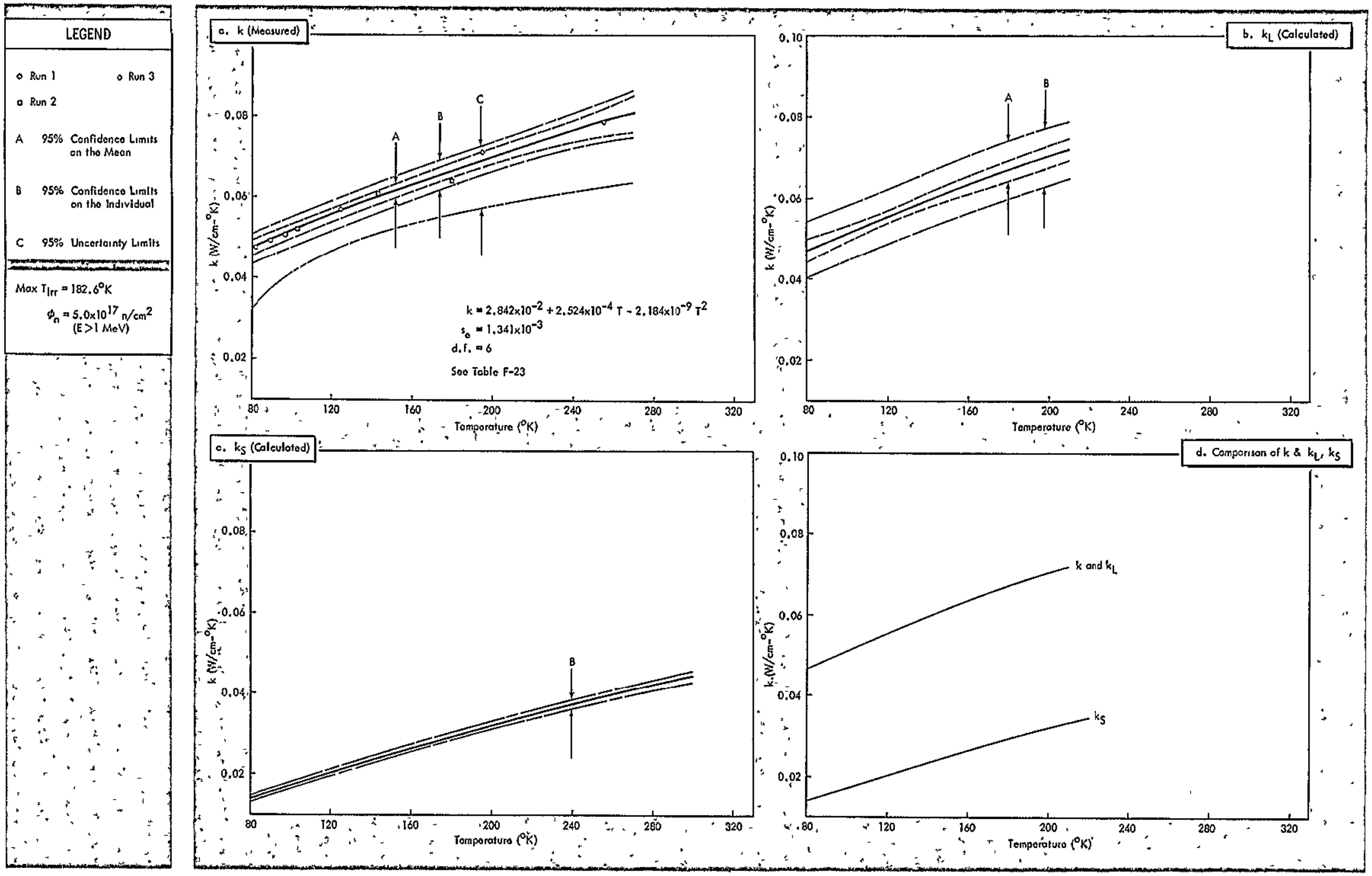

Figure 3-52 Experimental and Calculated Thermal Conductivity of Titanium as a Function of Temperature

3.7.2.5 PO-3 Graphite

The effective Lorenz ratios for graphite are presented in Figure 3-53. As previously noted, the Wiedemann-Franz Law does not hold for graphite and these data are presented as empirical data for informative purposes.

Figure 3-54 presents the thermal conductivity data calculated using the Wiedemann-Franz Law and a comparison plot with the measured values. These data are presented only for informative purposes as empirical data.

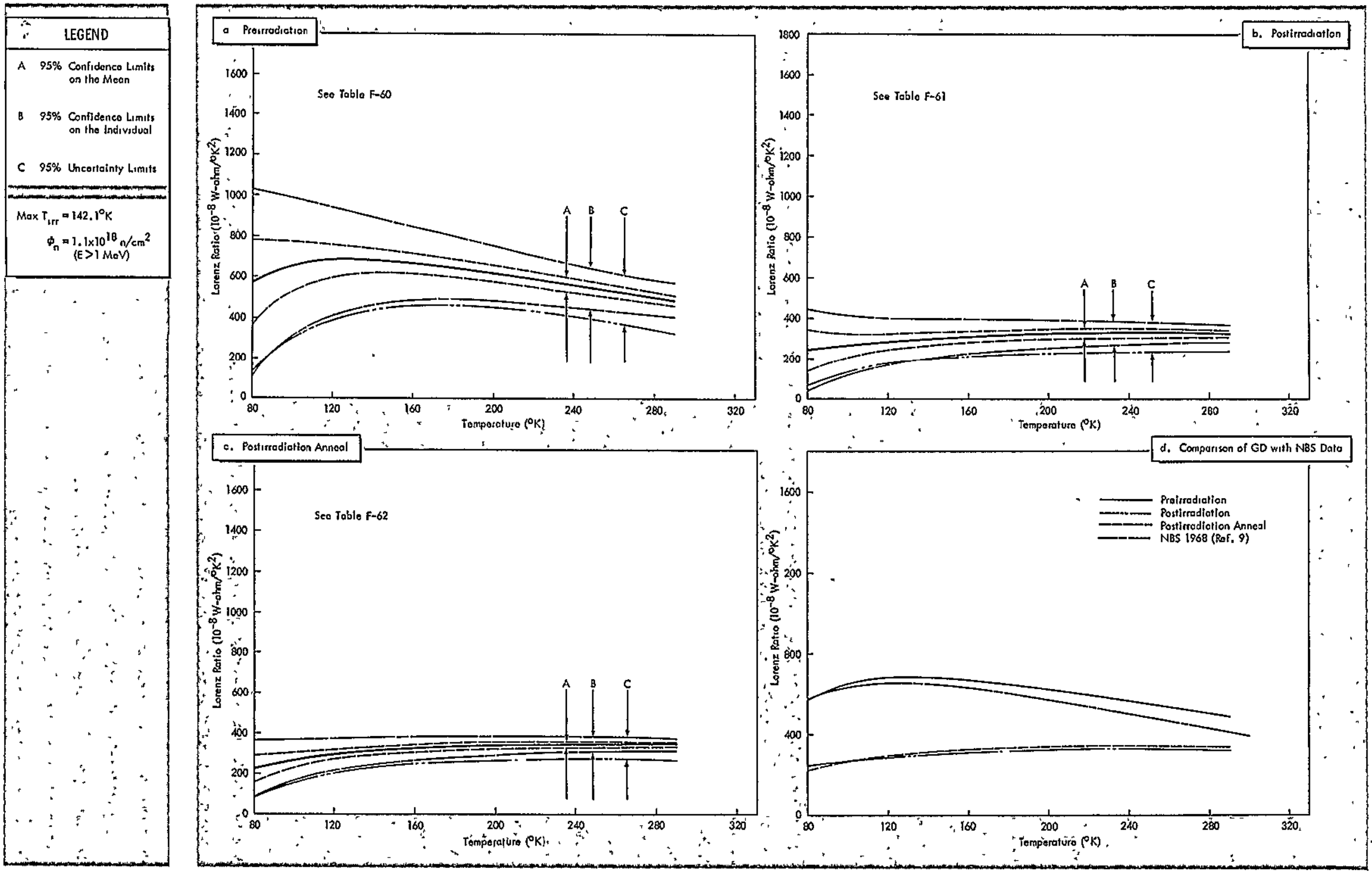

Figure 3-53 Effective Lorenz Ratio of PO-3 Graphite as a Function of Temperature

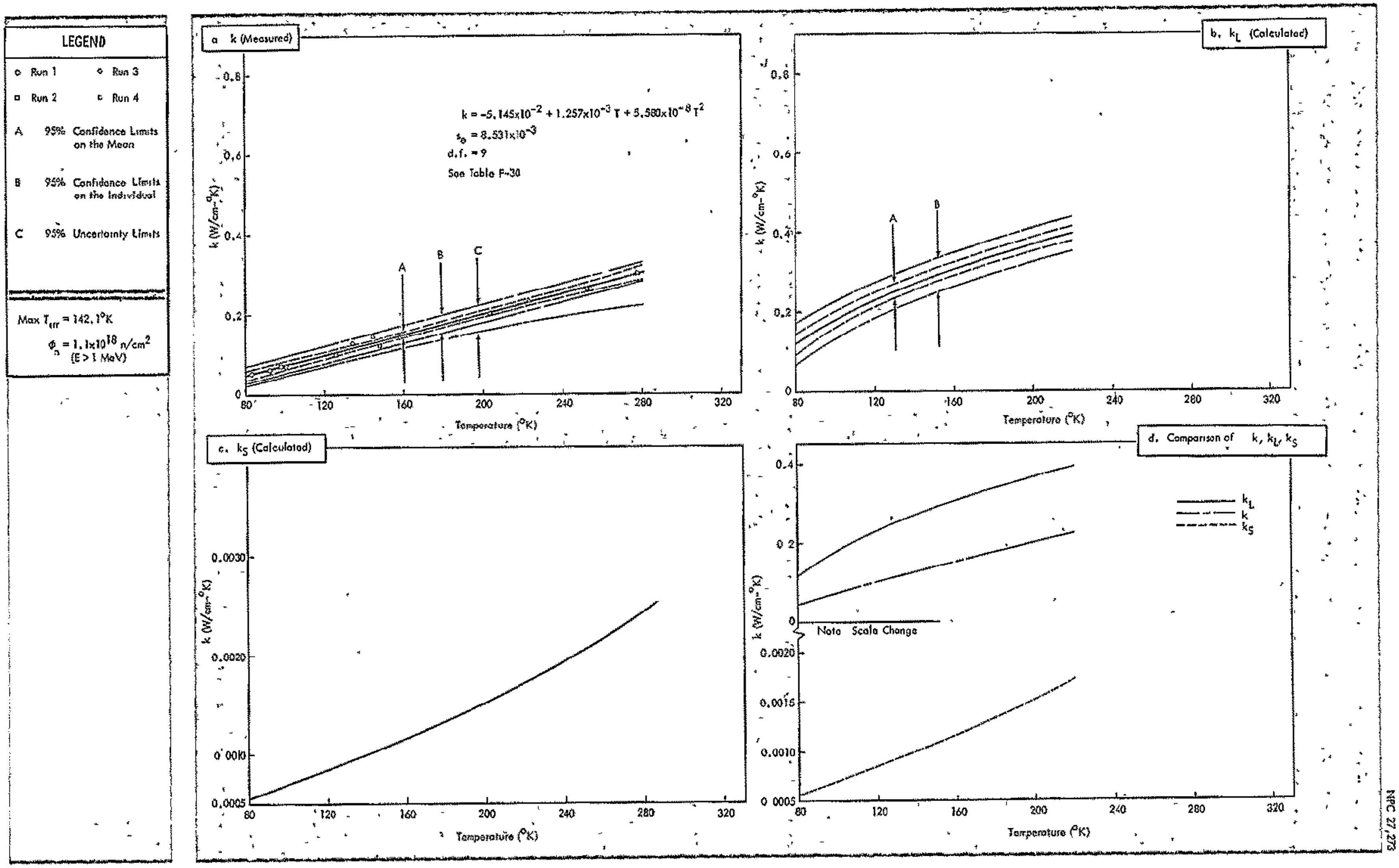

Figure 3-54 Experimental and Calculated Thermal Conductivity of PO-3 Graphite as a Function of Temperature

3.7.3 Summary

From the discussion of the mechanisms of thermal and electrical resistance and the condition for the validity of the Wiedemann-Franz Law (Sec. 3.7), it should be clear that the Wiedemann-Franz ratio $k\rho/T$ is equal to the ideal Lorenz number only in very special cases. More specifically, the theory shows that the Wiedemann-Franz Law holds for the total thermal and electrical conductivities only if

1. The lattice thermal conductivity is negligible compared to the electronic thermal conductivity, and

2. Electron-phonon scattering is negligible compared to electron-defect scattering, or

3. The electron energy loss suffered in electron-phonon collisions is negligible. The Wiedemann-Franz Law is then applicable to the electron-phonon resistivity as well as the electron-defect resistivity.

Conditions 1 and 3 are satisfied at high temperatures, thus explaining the well-known applicability of the law at such temperatures. However, for most of the specimens at temperatures of interest in the present experiment, none of the above conditions are satisfied. The straightforward application of the ideal Wiedemann-Franz Law to the total thermal and electrical resistivities is therefore invalid. This fact is illustrated in Figures 3-45 through 3-54, which are plots of pre- and post-irradiation values of the Wiedemann-Franz ratio based on measurements

of k and ρ. Incidentally, it is possible to show that a Wiedemann-Franz ratio greater than the ideal Lorenz number implies that Condition 1 is not satisfied, i.e., the lattice conductivity cannot be neglected. Thus, the very large value of the ratio for titanium shows that the deviation from the ideal Lorenz number is due to a large lattice-conductivity component. This statement is also applicable for the graphite specimen.

If the above-mentioned conditions are not satisfied, it is of course impossible to predict radiation-induced changes in k from measurements of changes in ρ alone. However, if sufficient low-temperature data are available to permit isolation of the components of k and ρ, it is possible to express changes in k in terms of changes in ρ, as was done in the preceding section. The advantage to this approach is that it is theoretically sound - the ideal Wiedemann-Franz Law is used only where it is known to be valid, i.e., in the analysis of defect resistivity. The disadvantage is, of course, that extensive low-temperature data must be obtained and analyzed to accomplish the isolation of components.

Experimental investigations of k and ρ have shown that, for most metals, the Wiedemann-Franz ratio differs from the total Lorenz number by less than 20%, even at low temperatures. This suggests that the ratio is not very sensitive to changes in defect concentration and so should remain essentially constant

during irradiation. Thus, if it can be assumed that the ratio is not appreciably changed by irradiation, it should be possible to use measured preirradiation values of the ratio to calculate changes in k from measured changes in ρ. In other words, there is some purely empirical evidence which suggests that the form of the Wiedemann-Franz Law is approximately valid for predicting radiation effects on k, provided an effective Lorenz number (the preirradiation value of the Wiedemann-Franz ratio at the temperature of interest) is used in place of the ideal Lorenz number. If the effective Lorenz number is not available and the ideal value is used instead, the error in the prediction of changes in k should be proportional to the difference between the effective and ideal Lorenz numbers. One of the purposes of the present experiment was to test these ideas by comparing the Wiedemann-Franz predictions of radiation effects on k for beryllium, aluminum, and titanium with direct measurements of k. The results are shown in Figures 3-45 through 3-54. It should be noted that for titanium the use of the ideal Lorenz number would have introduced large errors because the effective value for titanium is almost three times the ideal value at 80°K. The data for beryllium and aluminum show that the use of an effective Lorenz number gives adequate accuracy (< 10%) in the prediction of postirradiation values of k. It is also evident that, for most engineering applications, the value of k calculated using the Sommerfeld

value of L would result in adequate data (within 20% of measured values) for aluminum and beryllium.

In conclusion, then, it can be stated that although the straightforward application of the Wiedemann-Franz Law to the prediction of radiation effects on k cannot be justified theoretically, the results of the present experiment for all materials except graphite indicate that the error involved is small, less than 10%, if the preirradiation value of the Wiedemann-Franz ratio is used in place of the ideal Lorenz number. In most metals the electronic thermal conductivity is greater than the lattice conductivity, and predictions based on the ideal Lorenz number are probably adequate for most applications. However, it should be noted that there are exceptional cases, such as the titanium specimen used in the present experiment, where the lattice conductivity is dominant and the use of the ideal Lorenz number leads to a serious underestimate of k. Thus, the ideal Wiedemann-Franz Law should be used only in situations where there is sufficient evidence to ensure that the thermal conductivity is not dominated by the lattice component.

3.8 Conclusions and Recommendations

Because of the marked effect of the radiation environments of this test on the thermal conductivity and electrical resistivity of beryllium and graphite, it is recommended that further experiments be conducted to verify and thereby add confidence to the results obtained.

If further tests of this nature are conducted, it is strongly recommended that the test units be modified to include the following improvements:

1. Install a floating heat sink. This would permit raising of the reference junction temperature to some value above that of the reference bath. It would eliminate the need for large temperature gradients across the specimen at high temperatures and also enable one to obtain higher specimen temperatures than are now possible.

2. Replace the existing shield configuration with a universal shield, eliminating the need for the shield to be of the same material as the specimen. This could be accomplished by installing several shield heaters along the length of the shield, one at the bottom and one in the plane of each specimen thermocouple. Differential thermocouples from the specimen to the shield a each specimen thermocouple location would then ensure that the shield and specimen were at the same temperature.

3. Redesign the experimental system so that the test unit can be flooded with liquid nitrogen during the irradiation period. This could be accomplished with a gravity-flow liquid-nitrogen loop. This flooding would make possible the packing of fiberglass in the void between the specimen and the shield, thus minimizing the thermal leakage during thermal-conductivity data cycles at high specimen temperatures. Flooding with LN_2 would also result in the ability to irradiate the unit at higher power levels and therefore to higher neutron fluences. This is so because gamma heating during irradiation would be significantly reduced.

The improvements listed above would result in the following:

1. Improved data uncertainty.

2. Higher neutron fluences without the problem of possible annealing-out of radiation-induced changes resulting from gamma heating.

3. Higher possible specimen temperatures than are obtainable with the present configuration. This would result in the ability to determine percent recovery in k and ρ as a function of temperature, which was not possible with the present configuration.

An alternative to additional thermal-conductivity/electrical-resistivity irradiation experiments would be to construct one or more laboratory "standard" thermal-conductivity/electrical-resistivity test units similar to the one recommended above but without the liquid-nitrogen loop. These units would then be used to establish preirradiation effective Lorenz ratios on prospective test specimens. The specimens, after removal from the standard unit, would then be irradiated and electrical resistivity data taken in a manner similar to that described in Part II of this report. The effect of radiation on the thermal conductivity of the specimen could then be obtained from the relationship

$$k = \frac{L_{eff}\,T}{\rho}$$

In the first method, redundant measurements are made, i.e., both thermal-conductivity and electrical-resistivity measurements are made before and after irradiation, adding a degree of confidence to the results. In the alternative method, redundancy and possibly some degree of accuracy are sacrificed for a significant

reduction in experimental costs. However, with this standard unit, the effective Lorenz ratios could be determined more accurately over the temperature range of interest, probably resulting in predicted changes in k from measured changes in ρ with relative accuracies as good or better than those obtained by direct methods in this experiment.

In the case of graphite, where insignificant annealing occurs at room temperature, it would be possible to obtain both pre- and postirradiation values of thermal conductivity directly without subjecting the standard test unit to radiation exposure.

Part 2

ELECTRICAL RESISTIVITY

Test 37/R201

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IV. TEST PROGRAM FOR ELECTRICAL RESISTIVITY TEST 37/R201

The objectives of the electrical resistivity experiment were:

1. To measure the electrical resistivity of prospective NERVA materials before and after irradiation to a neutron fluence of approximately 5×10^{17} n/cm^2 (E > 1.0 MeV) at temperatures ranging from 77.4° to 466°K

2. To determine the extent to which radiation-induced changes in electrical resistivity were annealed at elevated temperatures

3. To determine the applicability of the Wiedemann-Franz Law for predicting the thermal conductivity of materials irradiated at cryogenic (LN_2) temperatures.

4.1 Technical Approach

The test specimens, which were supplied by AGC, are described in Table 4-1; a simplified diagram of the test circuitry is shown in Figure 4-1.

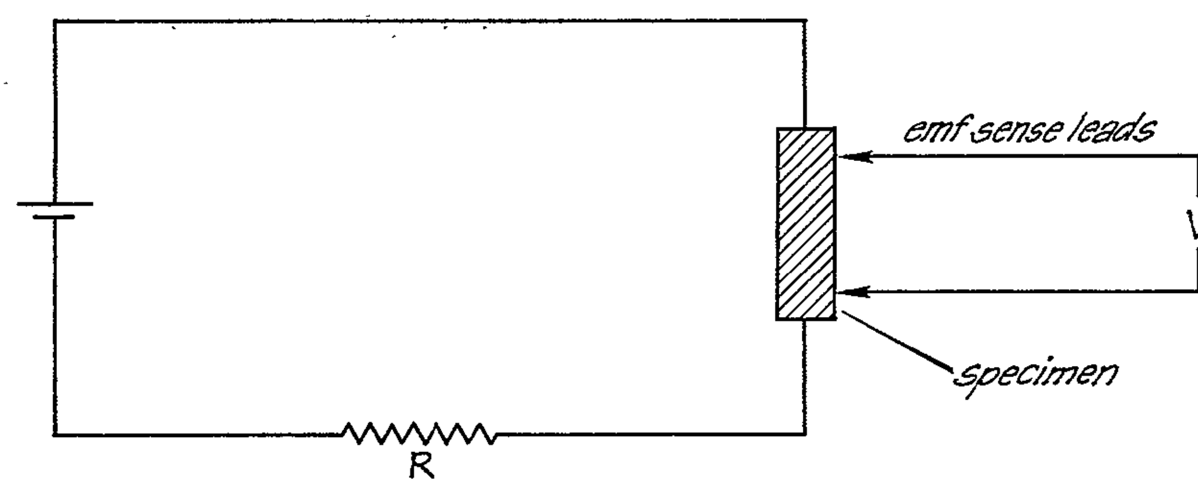

Figure 4-1 Simplified Sketch of Electrical-Resistivity Circuitry

Table 4-1

DESCRIPTION OF ELECTRICAL-RESISTIVITY TEST SPECIMENS

Material	Specimen Diameter (cm)	Distance Between emf Leads (cm)
Aluminum 7039-T61 (1)	0.152	7.859
Aluminum 7039-T61 (2)	0.152	7.620
Beryllium (2)	0.406	5.636
Inconel 718	0.444	8.672
Titanium (5 Al-2.5 Sn-ELI)	0.447	9.388
A-286	0.447	9.576
Hastelloy X	0.447	8.760
AISI-347 Stainless Steel	0.450	9.241
Graphite PO-3	0.445	7.775
Inconel*[a]	0.445	9.398

[a]This specimen was identified only as some type of Inconel.

The first step in determining the electrical resistivity was to measure the thermal emf across the specimen with no externally applied voltage. The measurement was then repeated with current flow through the specimen. The difference between the two measurements is the true emf across the specimen, the true emf being defined as the emf generated by current flow. The current flowing through the specimen was calculated from the measured potential drop across a known resistance, R, in series with the specimen.

The electrical resistivity ρ was calculated from $\rho = VA/IL$ where V is the true emf across the specimen in microvolts, A is the cross-sectional area in cm^2, I is the current flowing through the specimen in amperes, and L is the length of specimen between the emf leads in cm.

The first objective was accomplished by using the above procedure, both before and after irradiating the specimens, to measure the electrical resistivity at temperatures ranging from 77.4° to $466^{\circ}K$.

The second objective was accomplished after irradiation by alternately heating the specimens to successively higher temperatures and cooling them to LN_2 temperature. Resistivity measurements were made at each temperature step and at the subsequent LN_2 temperature. Detailed procedures concerning the first and second objectives are discussed in Section 4.3.

To meet the third objective, the thermal conductivity of the specimens was calculated by use of the experimentally measured electrical resistivity and the Wiedemann-Franz Law,

$$k = \frac{LT}{\rho} \tag{4-1}$$

where L is the Sommerfeld Value (2.44×10^{-8} watt-$\Omega/{}^{o}K^2$), T is the temperature (^{o}K), ρ is the electrical resistivity ($\mu\Omega$-cm), and k is the thermal conductivity (watt/cm-^{o}K). The applicability of this procedure was determined by comparing the calculated thermal conductivity to the experimentally measured thermal conductivity.

4.2 Experimental Equipment

4.2.1 Resistivity Test Assembly

The resistivity test assembly was designed and built by Aerojet-General and was supplied with the specimens installed. The internal assembly, shown in Figure 4-2, consisted of circular upper and lower copper base plates interconnected at the center by a copper support rod. A series of matching holes was drilled in each of the end plates to position the specimens. The specimens were threaded into the holes of the copper base plate to ensure positive electrical contact with this common-current connection.

The temperature of each specimen was monitored by 5-mil Chromel-constantan thermocouples calibrated using standard techniques (Appendix D). These thermocouples were attached to the

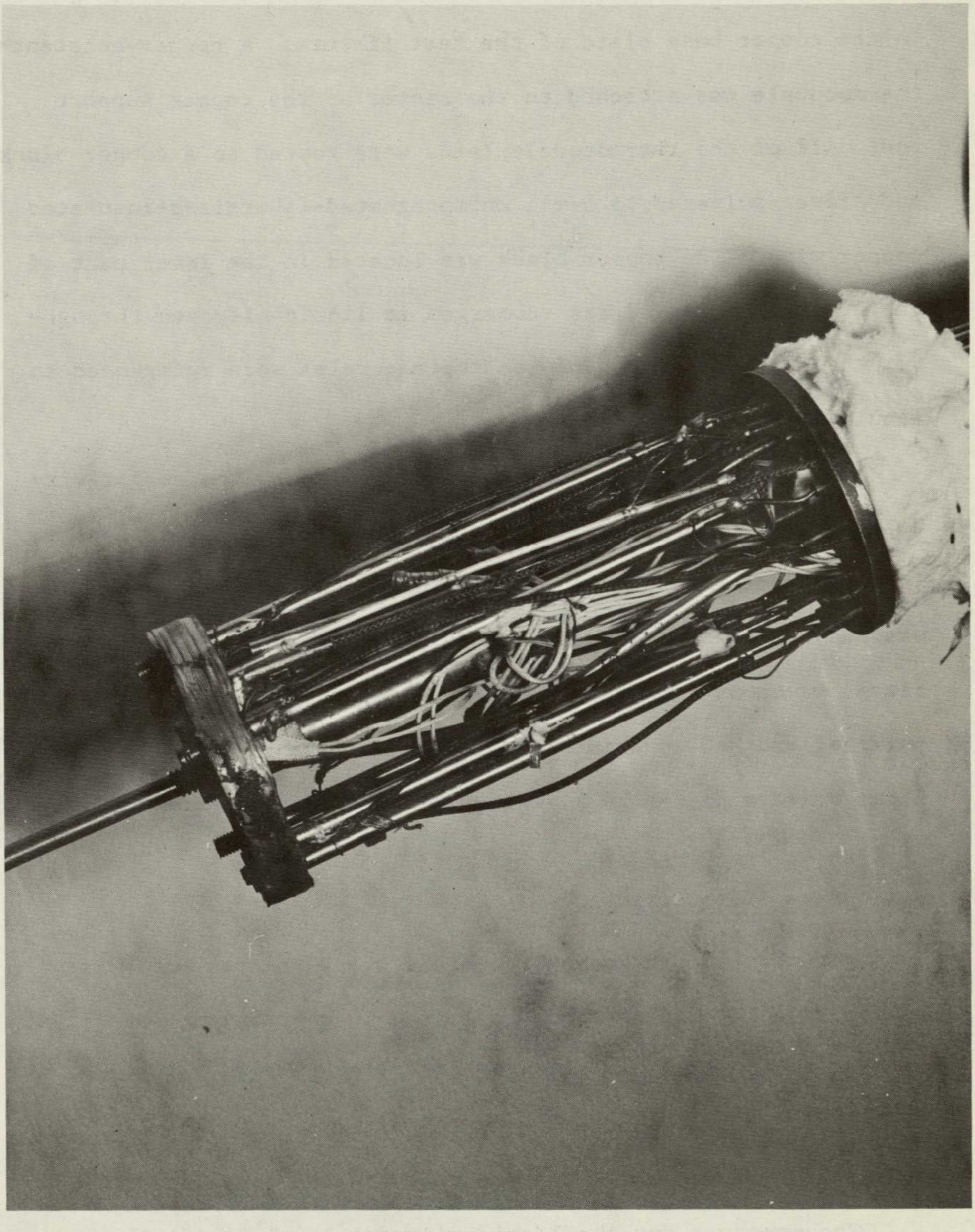

Figure 4-2 Electrical Resistivity Test Assembly

centers of each specimen, to each end of the A-286 specimen, and to the copper base plate of the test fixture. A copper-constantan thermocouple was attached to the center of the copper support rod. All of the thermocouple leads were routed to a copper block and silver-soldered to 5-mil unimpregnated-fiberglass-insulated copper wire. The copper block was located in the lower part of the cryogenic box and was submerged in liquid nitrogen throughout the test; thus, all of the thermocouples were referenced to liquid-nitrogen temperature.

After making the thermocouple connections, the resistivity test assembly was placed in an aluminum cylinder. Two 16-gage, Inconel-sheathed, MgO-insulated Nichrome heater wires were wrapped around the cylinder and held in place by an aluminum clamp, as shown in Figure 4-3. The heaters were connected in parallel and had a resistance of 5 ohms. The Nichrome heater wires were connected to stainless-steel-sheathed, MgO-insulated, 16-gage copper power leads.

4.2.2 Cryogenic Box

During the irradiation the resistivity test assembly was submerged in liquid nitrogen contained in a cryogenic box (Figs. 4-4 and 4-5). This box was basically a rectangular aluminum container having a smaller inner container to hold the liquid nitrogen. No vacuum was used between the two containers.

The pressure and the liquid-nitrogen level inside the cryo-

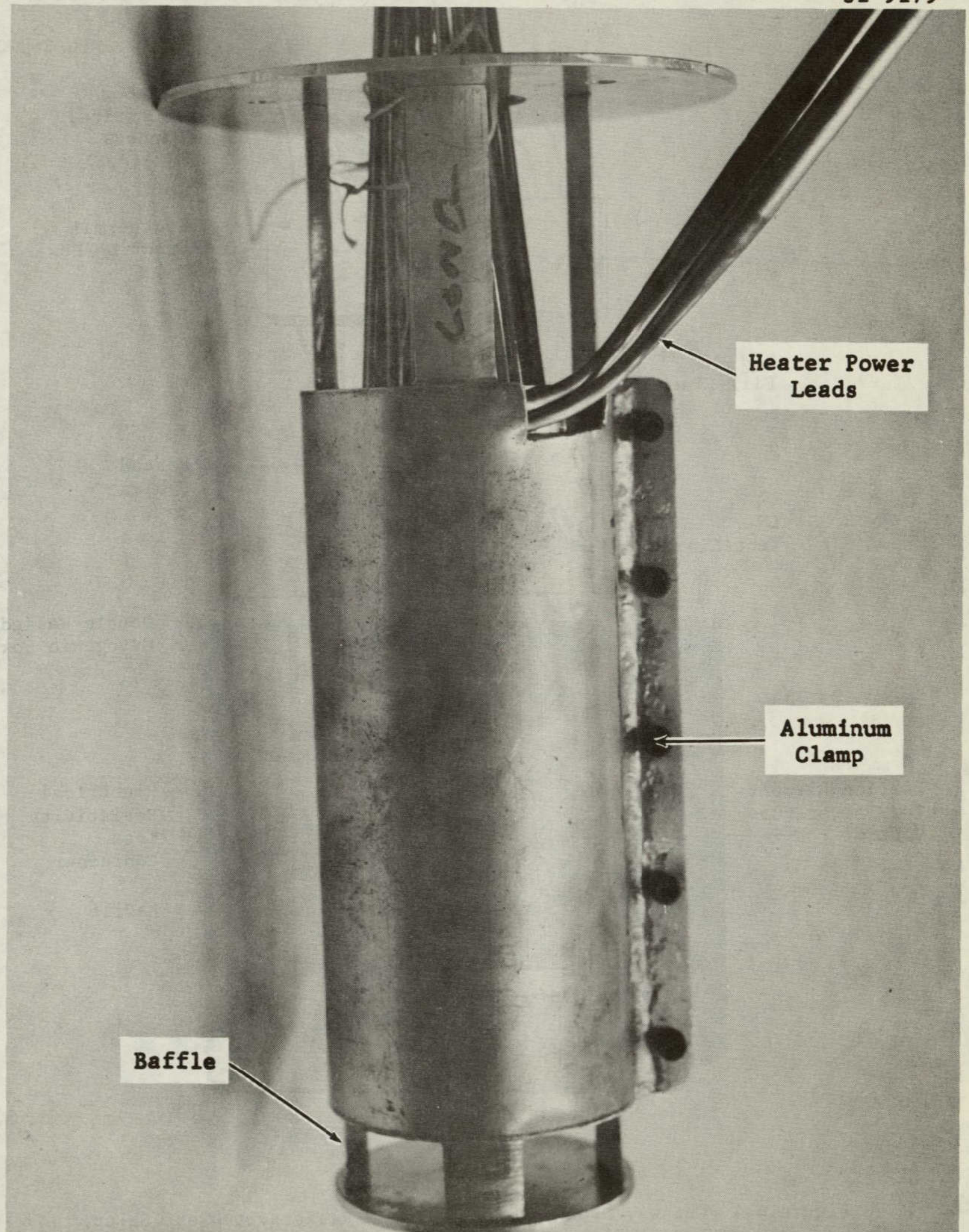

Figure 4-3 Electrical Resistivity Test Assembly Inside Aluminum Cylinder

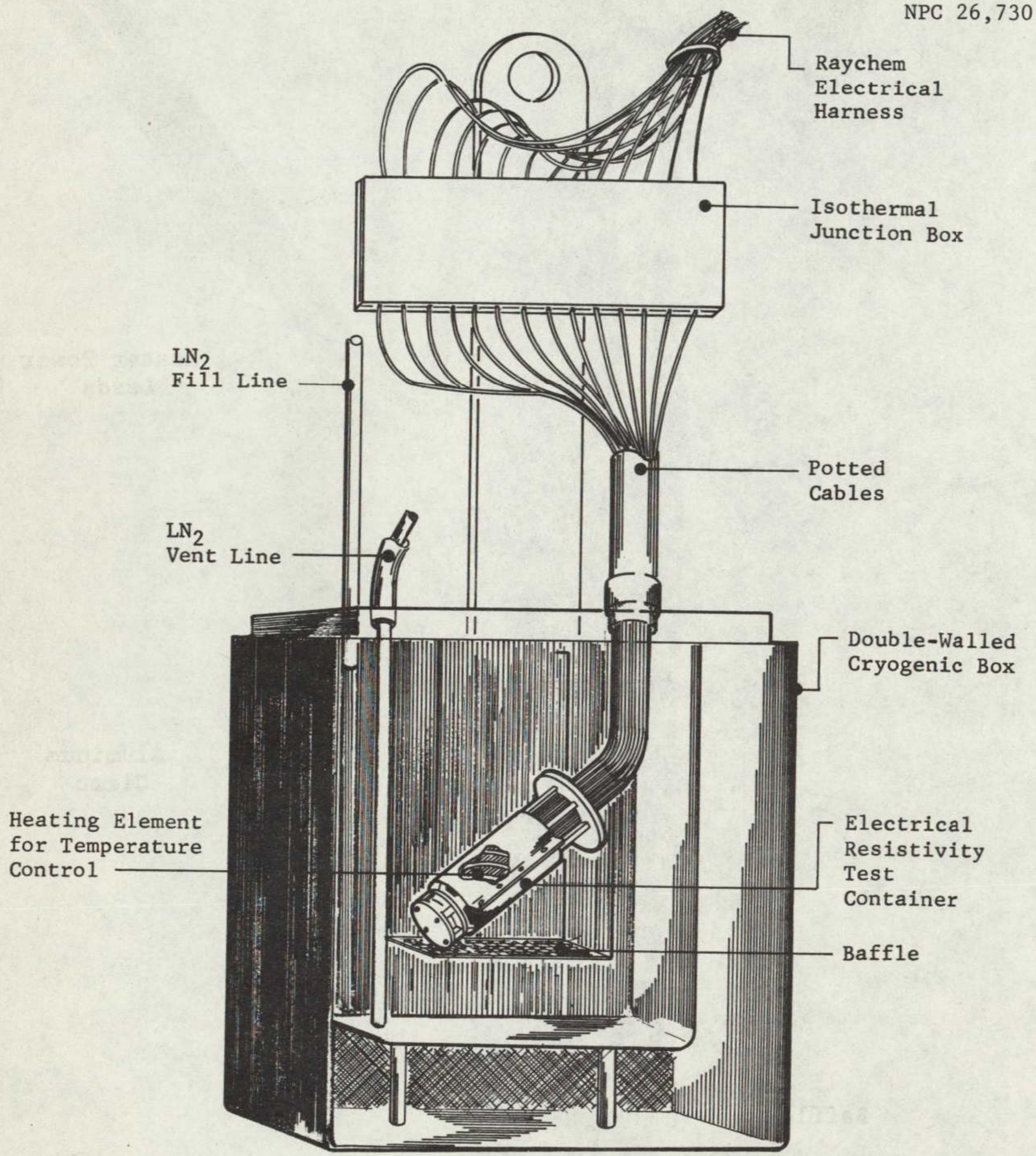

Figure 4-4 Cutaway Drawing of Electrical Resistivity Test Setup

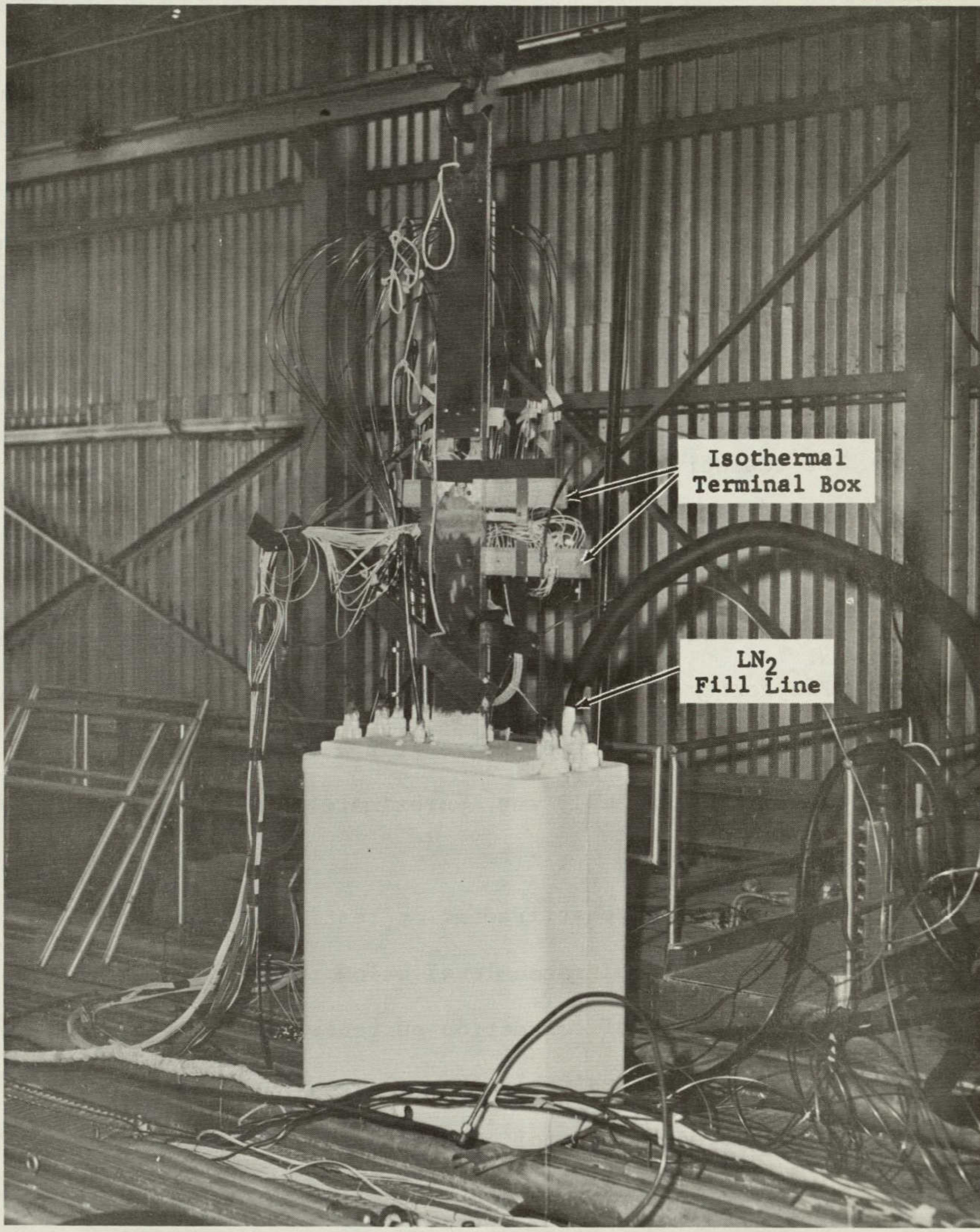

Figure 4-5 Cryogenic (LN_2) Box

genic box were monitored continuously. A CEC pressure transducer was used to monitor the pressure; a GDFWD liquid-level system was used to monitor and control the liquid-nitrogen level. One liquid-level probe with 12 resistors was used in conjunction with an indicator panel to monitor the liquid level. Another probe with 12 thermocouples was used in conjunction with a Bristol control unit to control the liquid level. The spacing of the thermocouples and resistors is shown in Figure 4-6.

The resistivity test assembly was mounted in a fixture fastened to the underneath side of the cryogenic-box lid, as shown in Figure 4-7. The test assembly was positioned so that each specimen was parallel to the reactor side of the cryogenic box. The center of mass was approximately 8 in. from the bottom face of the lid. With the cryogenic box in the irradiation position, the test assembly was approximately 9 in. from the reactor closet.

During pre- and postirradiation testing, it was necessary to lower the liquid-nitrogen level below the resistivity assembly. This created a flow of convection currents about the test assembly, resulting in undesirable thermal gradients across the specimens. To reduce the thermal gradients, a baffle arrangement was used. One baffle, attached to the lid of the cryogenic box, was located below the resistivity test assembly (Figs. 4-4 and 4-8). With the lid on the box, the baffle was in a plane 13 in.

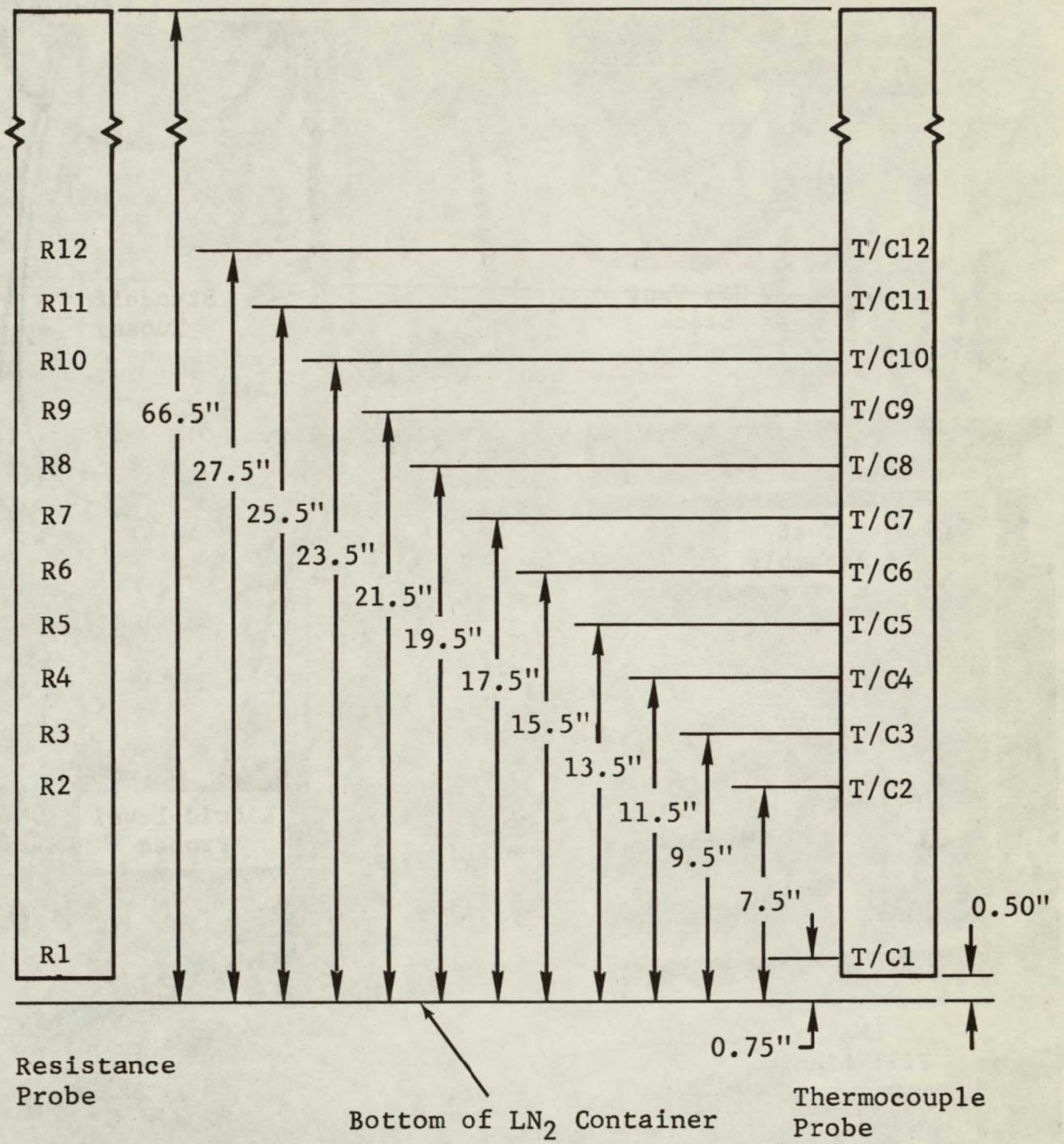

Figure 4-6 Liquid-Level Probes

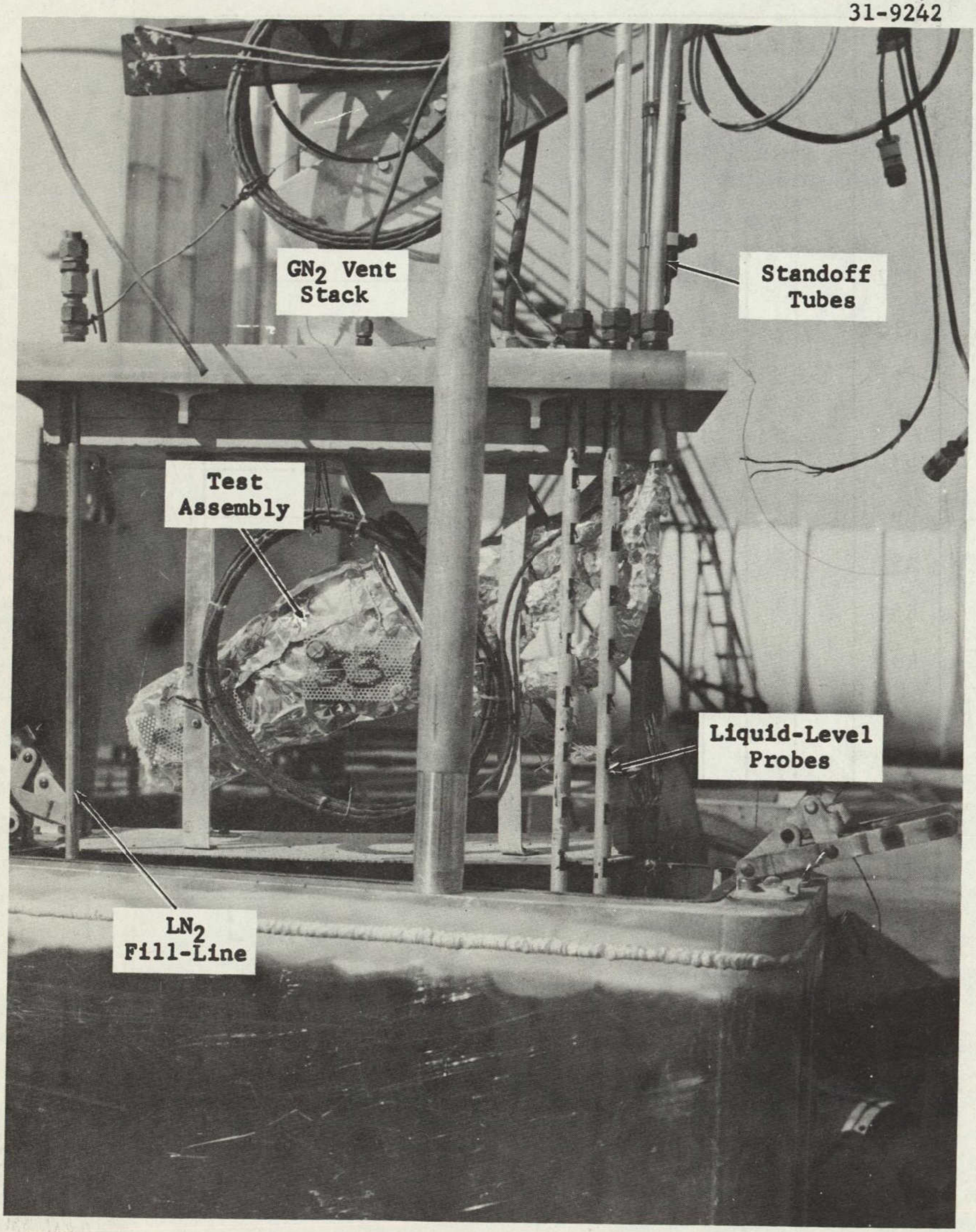

Figure 4-7 Electrical Resistivity Test Fixture (After Irradiation)

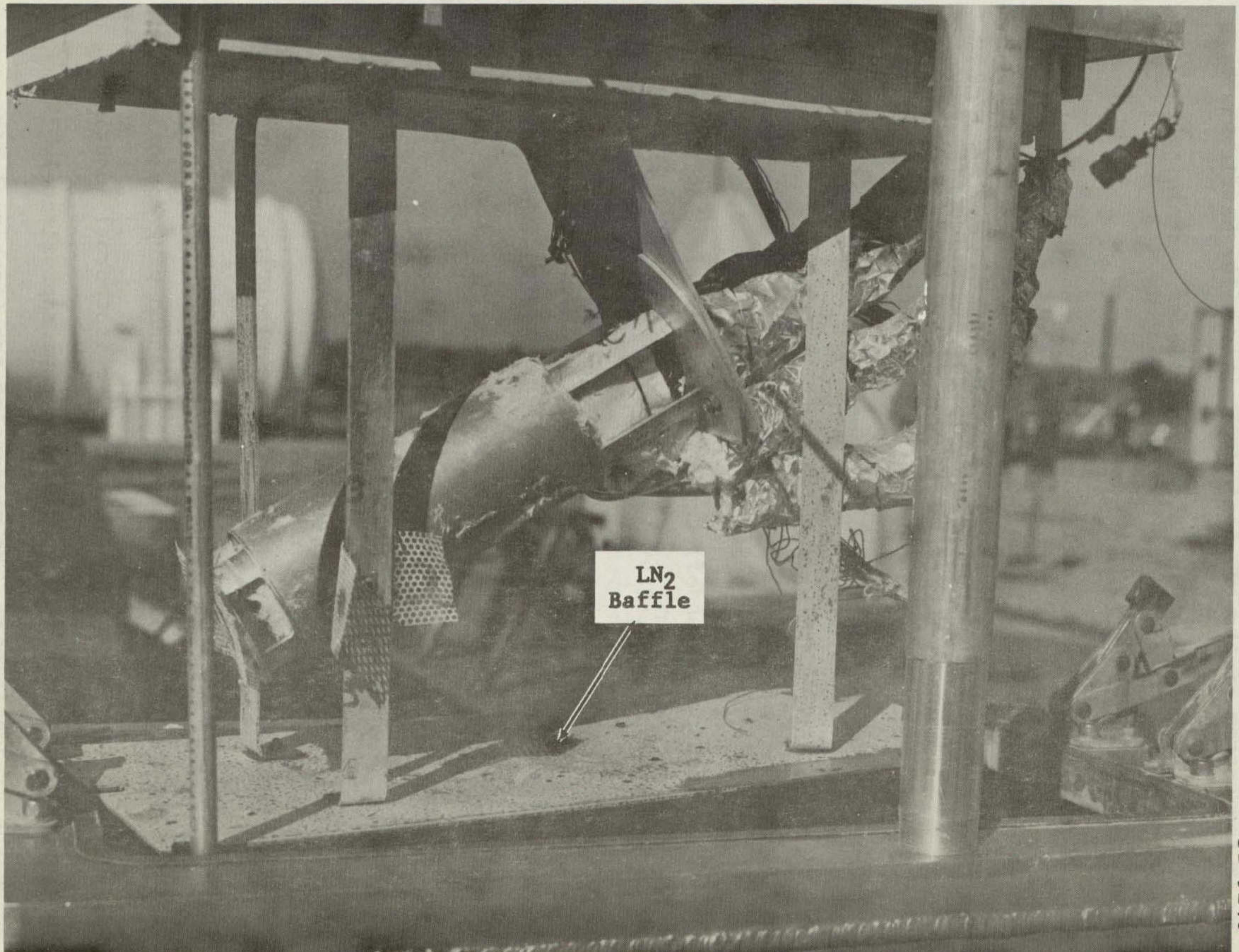

Figure 4-8 Electrical Resistivity Fixture Attached to Lid of Cryogenic Box (After Irradiation)

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above the bottom of the cryogenic box. A smaller baffle was mounted to the bottom of the aluminum cylinder containing the resistivity test assembly (Fig. 4-3).

In addition to the baffle arrangement, Fiberfrax insulation was used to reduce the thermal gradient across the specimens. The Fiberfrax served a dual purpose in this experiment: it increased the efficiency of the heater and decreased the thermal gradient across the specimens. Several arrangements of Fiberfrax were used to determine the configuration that would yield the smallest thermal gradient across the specimens.

Three separate standoff tubes were attached to the lid of the cryogenic box (Fig. 4-7). The voltage, thermocouple, current, and heater leads were passed through these tubes, which terminated approximately 30 in. above the cryogenic box. The tubes, which were sealed on the end with Shell Epon 954, were used to keep moisture away from the electrical leads.

Except for the heater leads, all of the leads emerging from the standoff tubes were routed to isothermal junction boxes at which they were connected to the electrical harness extending to the control room; the heater leads were connected to the electrical harness by means of a cannon plug approximately 10 ft from the cryogenic box. The isothermal junction boxes were mounted on an eye-hook structure approximately 3 ft above the cryogenic box. The purpose of the isothermal boxes

was to maintain a more uniform temperature at the electrical connections, thereby reducing thermally induced voltages. A 1000-watt strip heater, which was also mounted on the eye-hook structure, was used to keep moisture and frost away from the junction boxes.

In an effort to reduce radiation damage to the Raychem wire used in the electrical harness, a lead and water shield, 40.5 by 24.5 by 2.5 in. thick, was designed and fabricated at GDFWD. The shield was suspended from the reactor closet in such a manner that one edge was just above the cryogenic box and one side was in contact with the east face of the reactor closet (Fig. 4-9). All electrical connections to the harness, with the exception of those to the heaters, were made behind this shield.

4.2.3 Instrumentation

Parameters used in calculating the electrical resistivity were measured with a Dymec 2010-D digital data-acquisition system and an L&N K-4 potentiometer. A detailed sketch showing the circuitry and the associated instrumentation is shown in Figure 4-10. All the specimens except A-286 steel and AISI-347 stainless steel had a separate power supply and individual circuits with a common current connection at the copper base plate of the test assembly. Either a Kepco Model 325-1AM (0-400 V dc, 0-1 A) or a Kepco Model SM-74 AM (0-80 V dc, 0-2 A) power supply was used for these circuits. The A-286 steel and

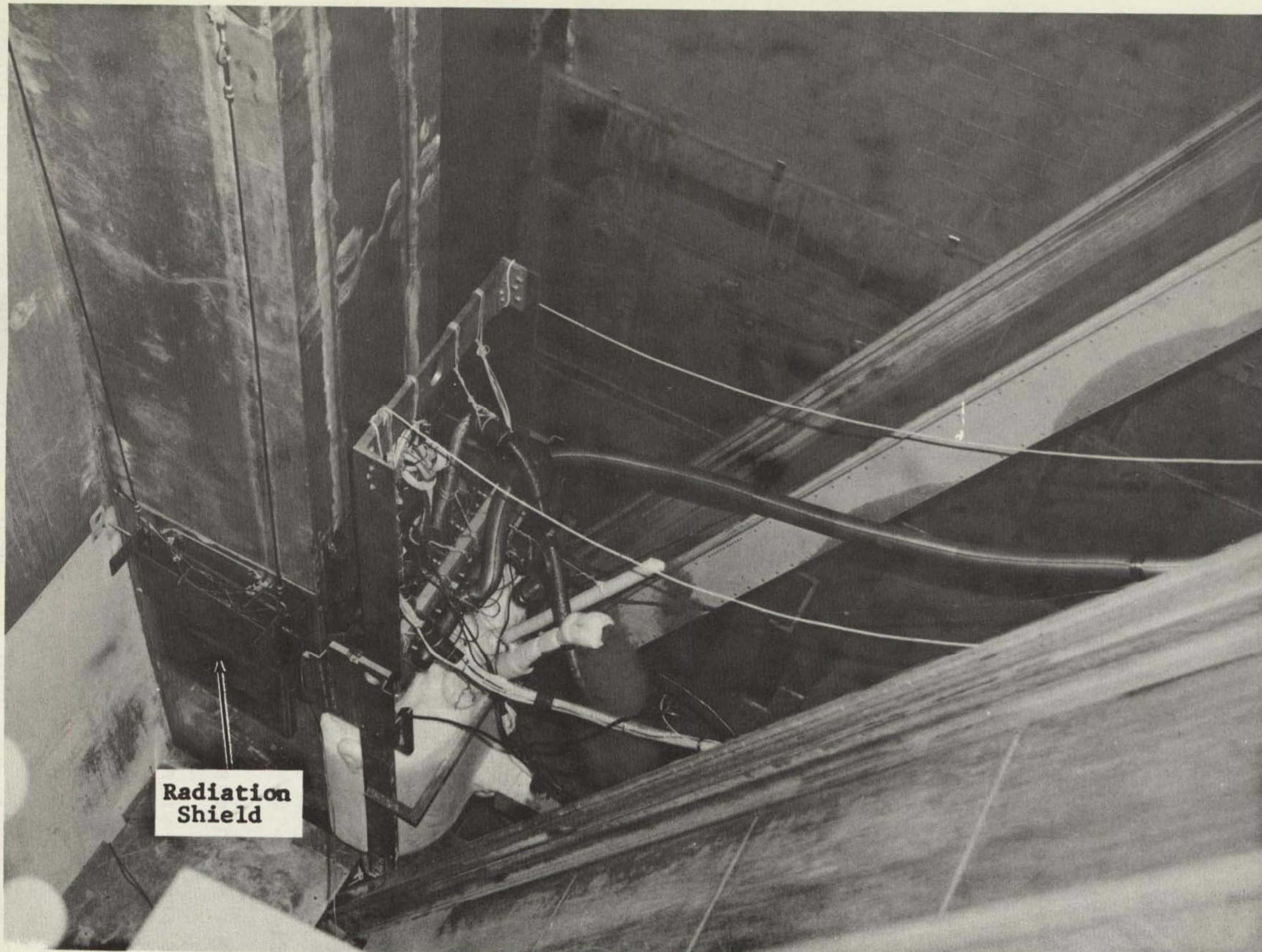

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Figure 4-9 Electrical Resistivity Radiation Shield

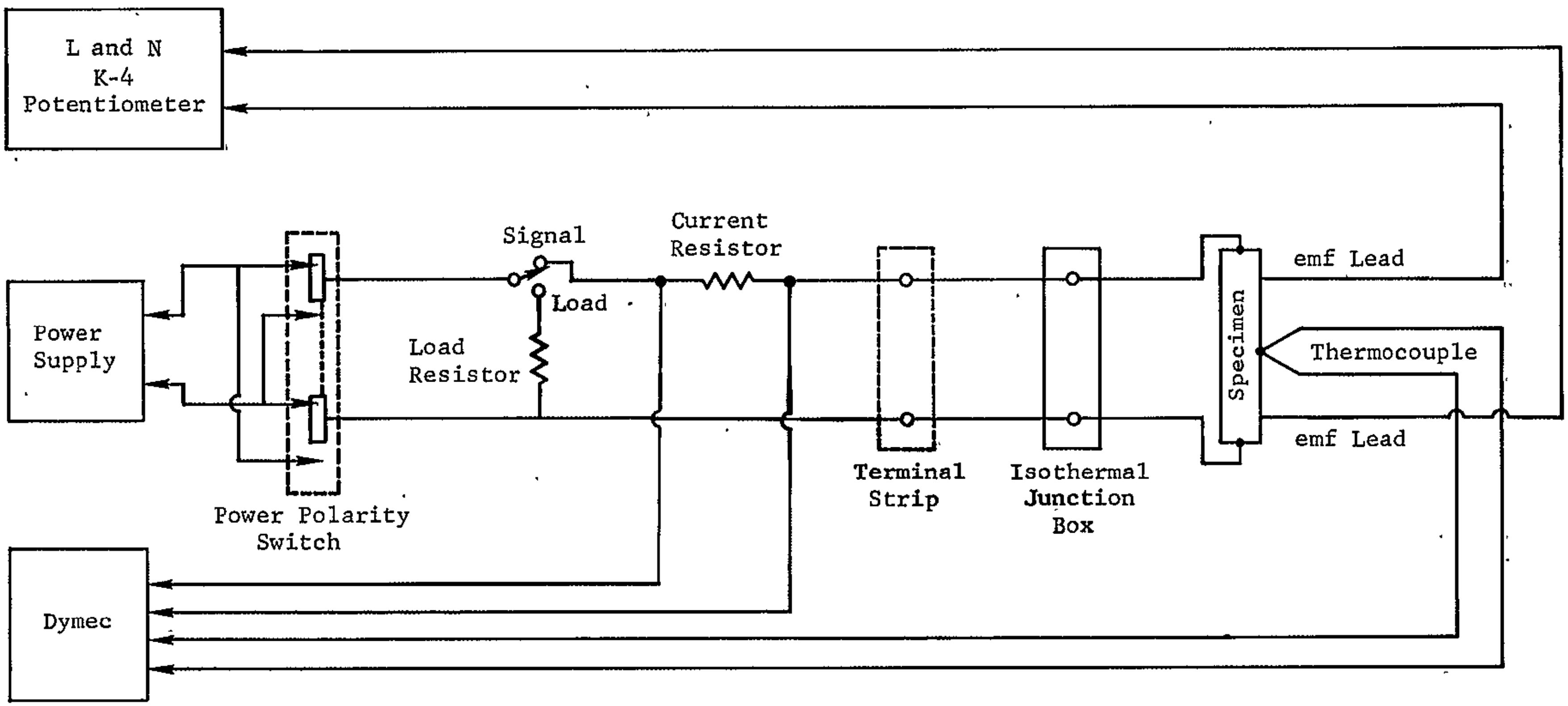

Figure 4-10 Circuit Used to Measure Electrical Resistivity

AISI-347 stainless-stell specimens had separate circuits but a common dc power supply. A Kepco Model KS-60-20M (0-60 V dc, 0-20 A) power supply was used for heater power.

The Dymec was used to measure the potential output of the Chromel-constantan thermocouples. The L&N K-4 potentiometer, which is accurate to $\pm$ 0.5 μV, was used to measure the emf across a known section of the specimen.

The current through the heaters was computed from a measurement (with the Dymec) of the voltage drop across a 0.5-Ω resistor in series with the heaters. The heater current was correlated with the specimen temperature, and this permitted the required current for any selected temperature to be established.

Similarly, the voltage drop across the current resistor (Fig. 4-10) was used to calculate the current through a given specimen. The voltage drop was measured with the Dymec; the resistance of each current resistor had been measured, prior to installation, to an accuracy of 0.1% with a Wheatstone bridge. The load resistor (Fig. 4-10) had the same resistance as the current resistor. Switching to the load resistor permitted continuous operation of the power supply at a constant load.

Since the temperature of liquid nitrogen is pressure sensitive, the vapor pressure above the liquid was monitored with a CEC Type 4-312-0002 pressure transducer having a range of $\pm$ 5

psig and an absolute barometric dial-gage indicator. The pressures were used to determine the actual temperature of the liquid nitrogen for correction of the temperatures of the electrical resistivity specimens.

A Brown-Honeywell recorder was used to record the temperature of the copper-constantan thermocouple located on the center supporting bar in the resistivity assembly.

The polarity switch shown in Figure 4-10 permitted reversal of current direction through the specimen. The electrical resistivity of the specimen was calculated with the current flowing in one direction; the polarity switch was used to reverse the direction of current and the electrical resistivity was again calculated.

4.3 Test Procedures

Figure 4-11 illustrates the data-acquisition plan for preirradiation, irradiation, and postirradiation measurements. By applying power to the heater around the electrical-resistivity test assembly, the temperature of the specimens was stabilized at each of the temperatures indicated in the figure. Except for 422° and 466°K, three consecutive data cycles were obtained at each temperature. Each data cycle consisted of three measurements on each specimen: two voltage measurements, one for each direction of the current, and one temperature measurement from the thermocouple located midway on each specimen. Thus, at all

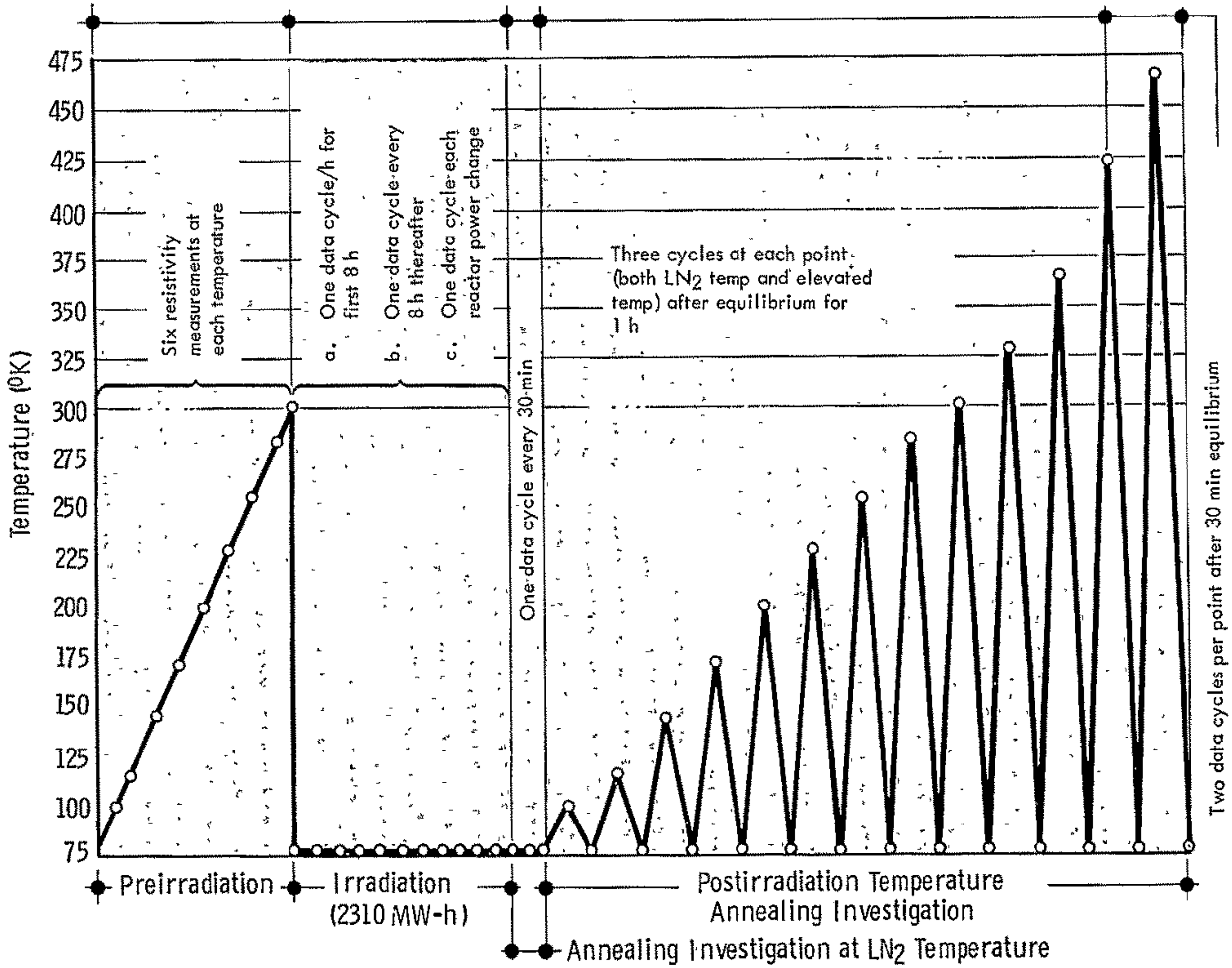

Figure 4-11 Electrical Resistivity Test Temperature Profile

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of the temperatures above LN_2 (except 422° and 466°K), at least six electrical resistivity determinations were made for each specimen. Only two data cycles were obtained at 422° and 466°K.

4.3.1 Preirradiation Test

In the preirradiation test at least three data cycles were run at each of the following temperatures (in °K): 77.4 (LN_2), 100 ± 5, 116 ± 5, 140 ± 5, 172 ± 5, 199 ± 5, 228 ± 5, 250 ± 5, 283 ± 5, and 300 ± 5. During each of the three cycles, the temperature of each specimen did not vary more than ± 1.1°K. From these data, six resistivity values were computed for each specimen at each temperature.

After obtaining the resistivity measurements at LN_2 temperature, the LN_2 level in the cryogenic box was lowered and maintained at thermocouple position T/C 4 (Fig. 4-6). Power was applied to the heater to raise the temperature of the specimens to between 95° and 105°K. With the temperature stabilized, three cycles of data were obtained. Additional power was then applied to the heaters to raise the temperature to the next desired level. This procedure was followed until all planned preirradiation measurements had been taken.

4.3.2 Irradiation Test

During the irradiation, the LN_2 level was maintained above the test assembly at thermocouple position T/C 11 (Fig. 4-6). One data cycle was made every hour for the first 8 hours of

reactor operation; after this, one data cycle was made every 8 hours. In addition, one cycle was made after each change in reactor power level.

4.3.3 Postirradiation Test

Upon completion of 2310 MWh of irradiation, a data cycle was run at 30-min intervals for the first 2 hours. The LN_2 level was then lowered and maintained at thermocouple position T/C 4. Heater power was applied and thermal equilibrium was established in the temperature range of 100 $\pm$ 5°K. Each specimen was maintained within $\pm$ 1.1°K of this temperature for 1 hour; at least three data cycles were run at the equilibrium temperature. After 1 hour at thermal equilibrium, the heater power was turned off and the LN_2 level raised above the specimens. When the specimens reached LN_2 temperature, three data cycles were taken. The above procedure was repeated not only for each of the temperatures at which preirradiation data were taken but also for the additional temperatures of 328 $\pm$ 5°K, 365 $\pm$ 5°K, 422 $\pm$ 5°K, and 466 $\pm$ 5°K. As mentioned earlier, only two cycles of data were obtained at the two highest temperatures and the specimens were in thermal equilibrium for only 30 min. Also, only two cycles of resistivity data were taken at the LN_2 temperature after the 422° and 466°K temperatures.

V. EXPERIMENTAL RESULTS

The data presented in this section are those obtained immediately before irradiation, during irradiation, and immediately after irradiation. The technique used in obtaining these data has been explained in Section IV.

A summary of the results of this experiment is given in Section 5.1. The precision and uncertainty of these data are discussed in Sections 5.2 and 5.3.

5.1 Summary of Results

Figure 5-1 shows the percent increase in electrical resistivity as a function of neutron fluence for graphite, beryllium, aluminum, and titanium. Table 5-1 gives the maximum increase in resistivity for each of the specimens after an exposure of 3.3×10^{17} n/cm^2 (E > 1.0 MeV); comments concerning annealing characteristics are included. In both the figure and the table, the resistivities are those at LN_2 temperature.

5.2 Precision of the Data

As explained in Section IV, at least six resistivity measurements were made at each temperature (except the two highest and the corresponding LN_2 cycles of the postirradiation anneal), and the precision of the experiment has been estimated from these data. The precision, or percent standard deviations, given in the tables have been computed as

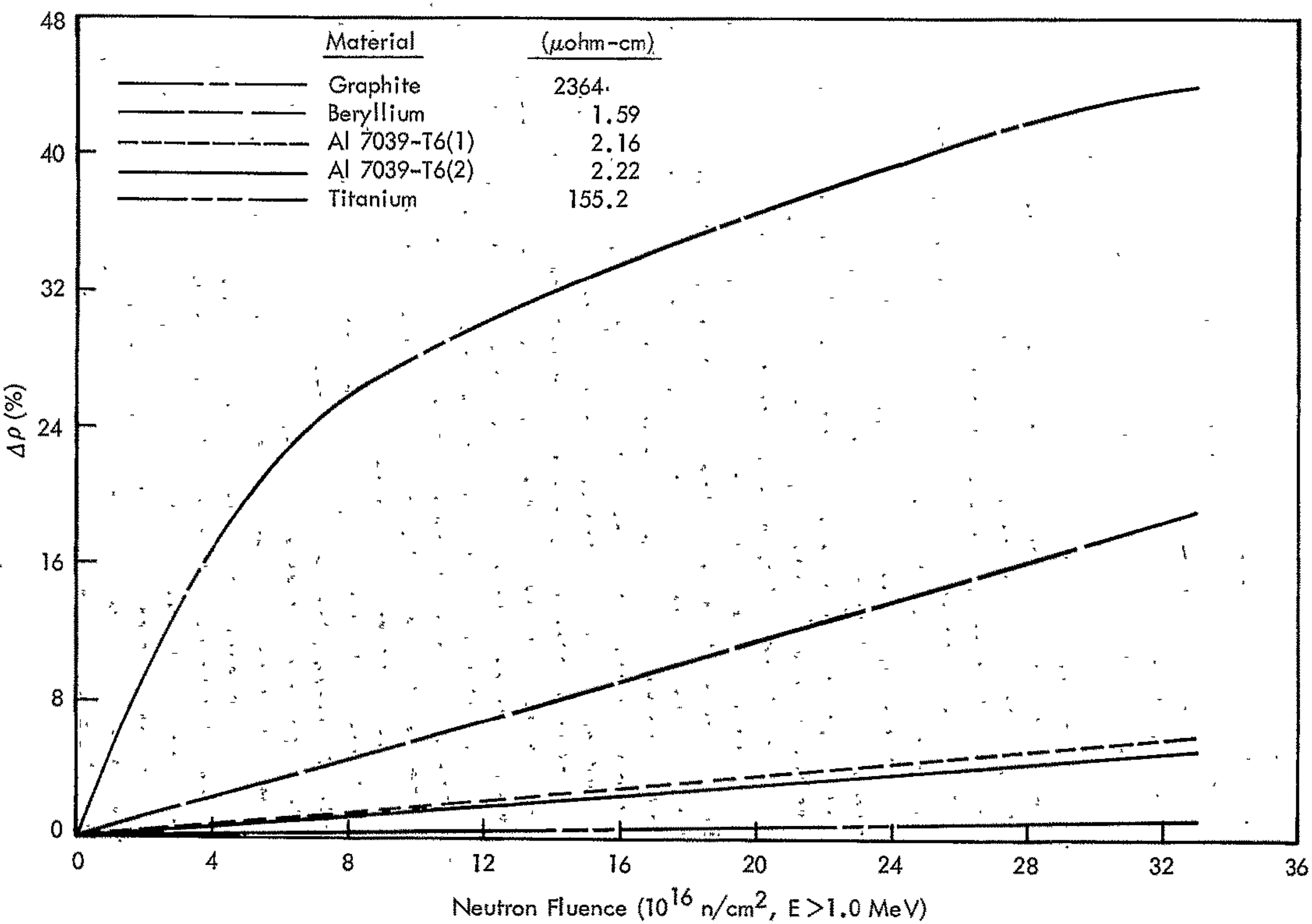

Figure 5-1 Percent Change in Electrical Resistivity at LN_2 Temperature as a Function of Neutron Fluence

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Table 5-1

CHANGE IN ELECTRICAL RESISTIVITY OF NERVA MATERIALS IRRADIATED TO 3.3 x 10^{17} n/cm^2 AT LN_2 TEMPERATURE

Material	($\mu\Omega$-cm) Initial	Final	Change in ρ ($\mu\Omega$-cm)	Change in ρ (%)	Exp. Unc. (±%)	Remarks
Graphite PO-3	2364	3409	+1040	+44.0	19.6	Nonlinear radiation effect; 10% residual change after annealing at 460°K.
Beryllium	1.59	1.90	+0.31	+19.5	10.5	Linear radiation induced change; complete recovery after anneal at 260°K.
Al 7039-T61(1)	2.16	2.29	+0.13	+6.0	2.6	Linear radiation induced change; complete recovery after anneal at 366.5°K.
Al 7039-T61(2)	2.22	2.33	+0.11	+5.0	1.7	Linear radiation induced change; complete recovery after anneal at 364.5°K.
Titanium Ti-5 Al-2.5 Sn, ELI	155.2	155.9	+1.7	+1.1	0.6	Linear radiation induced change; complete recovery after anneal at 461°K.
SS-347	57.1	57.5	+0.4	+0.7	0.9	Linear radiation induced change; complete recovery after anneal at 463°K.
Inconel 718	108.1	108.6	+0.5	+0.5	0.1	Linear radiation induced change; no recovery after anneal at 466°K.
A-286	76.3	76.6	+0.3	+0.4	0.9	Linear radiation induced change; 0.1% residual change after anneal at 464.5°K.
Inconel*	120.7	120.8	+0.1	+0.1	0.1	The change indicated is less than the experimental precision.
Hastelloy X	108.8	108.9	+0.1	+0.1	0.2	The change indicated is less than the experimental precision.

$$\% \text{ SD} = 100\ \sigma/\rho$$

where σ is the standard deviation and ρ is the average electrical resistivity.

Generally, the standard deviation of the data improved as the experiment progressed. The smallest standard deviations, most being less than 0.1%, were obtained for the postirradiation anneal data at LN_2 temperature. This is attributed to the constancy of the temperature with the specimens submerged in LN_2, whereas the higher temperatures were maintained to only $\pm$ 1°K while data were being taken. Although the temperature of LN_2 is pressure sensitive, the variations in temperature due to pressure changes were small enough to make corrections unwarranted. The temperature correction computed from the range of measured barometric pressures (733 to 756 mm-Hg) amounted to no more than 0.3°K. The pressure within the cryogenic box, measured with a transducer, remained at atmospheric pressure throughout the test.

Specimen temperature was the least controlled of all test parameters. Temperature gradients were known to exist across the specimens whenever they were not submerged in the cryogen. A general idea about the magnitude of the temperature gradient was obtained from thermocouples mounted on the top, center, and bottom of the A-286 specimen. Analysis of the data from these thermocouples indicated that temperature gradients were practi-

cally nonexistent at temperatures slightly higher than the temperature of LN_2. As specimen temperatures were increased, however, the temperature gradients increased. When the center thermocouple indicated a specimen temperature of 370°K, for example, the thermocouples at the top and bottom indicated 364° and 369°K, respectively. Because of the rather small difference and the limited amount of data, no corrections were made for thermal gradients. The temperatures given in the subsequent tables are those indicated by the thermocouple attached to the center of each specimen. These temperatures have been reported to the nearest 0.5°K.

At about 260°K a problem in controlling the liquid-nitrogen level resulted in somewhat unstable specimen temperatures which, in turn, increased the variation in the data at this temperature. Certain other anomalies in the data indicated by unusually large standard deviations have simple explanations which are discussed in the individual data sections.

5.3 Experimental Uncertainty

The experimental uncertainty of this experiment was determined in the same way as in the Thermal Conductivity/Electrical Resistivity Test, 37/R104. Since there was no bias, or systematic error, the experimental uncertainty is equal to the 95% confidence limits on the individual data points.

5.4 Presentation of Data

The experimental data for each specimen are presented in subsequent subsections. In each instance the data are presented as:

1. A plot of electrical resistivity as a function of temperature for pre- and postirradiation, at LN_2 temperature after each temperature step of anneal, and the change in electrical resistivity.

2. A plot of electrical resistivity at LN_2 temperature as a function of radiation exposure at zero reactor power.

3. A plot of calculated thermal conductivity and the change in thermal conductivity as a function of temperature for all specimens except graphite.

4. A tabulation of electrical resistivity measurements made before irradiation, after irradiation, and at postirradiation-anneal conditions. Relative standard deviations (in percent) are given for these data. The thermal conductivity computed by use of the equation in Section 4.1 is also given (except for graphite).

The curves shown in the following figures have been computed by least-squares fit using an IBM 360 computer. A statistical analysis has been performed as described in Section III. In cases where no limits appear on the individual curves, the limits are too small ($< 1\%$) to be drawn. In cases where only one set of limits appear, these are the 95% confidence limits on the individual values. Tabulated data for these curves are presented on Appendix G. A tabulation of electrical resistivity measurements made during irradiation is also presented in Appendix G for each specimen.

5.4.1 Titanium (Ti-5 Al-2.5 Sn-ELI)

The data for titanium are presented in Figures 5-2, 5-3, and 5-4, Table 5-2, and in Tables G-1 through G-6 of Appendix G.

Figure 5-2 presents the calculated preirradiation, postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 155.3 μohm-cm at 80°K to 183.1 μohm-cm at 300°K. The postirradiation data range from 157.1 μohm-cm at 80°K to 183.6 μohm-cm at 300°K to 198.8 μohm-cm at 460°K. The maximum change in ρ of 1.1% occurs at 80°K and decreases thereafter. The data taken at 77.4°K after each temperature step of the anneal, Figure 5-2(c), indicates that complete annealing had taken place at a temperature of 461°K.

The percent standard deviations given in Table 5-2 for the postirradiation and postirradiation-anneal data indicate that good precision was obtained in measuring the electrical resistivity of titanium. However, some of the percent standard deviations in the preirradiation data were larger than would be expected. This can probably be attributed to a poor connection between the current lead and the specimen. This condition was discovered before the test, but an attempt to reconnect the current lead was unsuccessful. A fix was therefore made by connecting a jumper from the current lead, which was left

attached, to the voltage lead. The voltage measurement then became somewhat dependent upon how well the current lead was in contact with the specimen at a given time. Furthermore, the addition of the jumper altered the circuit so that the measured voltage drop included, in addition to the voltage across the specimen, the voltage across some additional copper wire and solder.

Figure 5-3 shows the electrical resistivity at LN_2 temperature to increase slightly and linearly as a function of neutron fluence. The experimental uncertainty in these data is approximately $\pm$ 3.5% at 80^oK.

The Wiedemann-Franz Law (Sec. 3.7) was used to calculate the pre- and postirradiation thermal conductivity values shown in Figure 5-4. Since there is a maximum of 1% difference between the pre- and postirradiation electrical resistivities, the thermal conductivities differ by at most 1%. In Figure 5-4 (a), NBS experimental thermal conductivity data (Ref. 8) have also been plotted for comparison. At LN_2 temperature, the calculated data are a factor of 3.4 lower than the measured data. From this it is concluded that the Sommerfeld Value should not be used to predict the thermal conductivity of titanium from electrical resistivity data. Figure 5-4(b) is a comparison of the change in the 37/R201 specimen and the 37/R104 specimen.

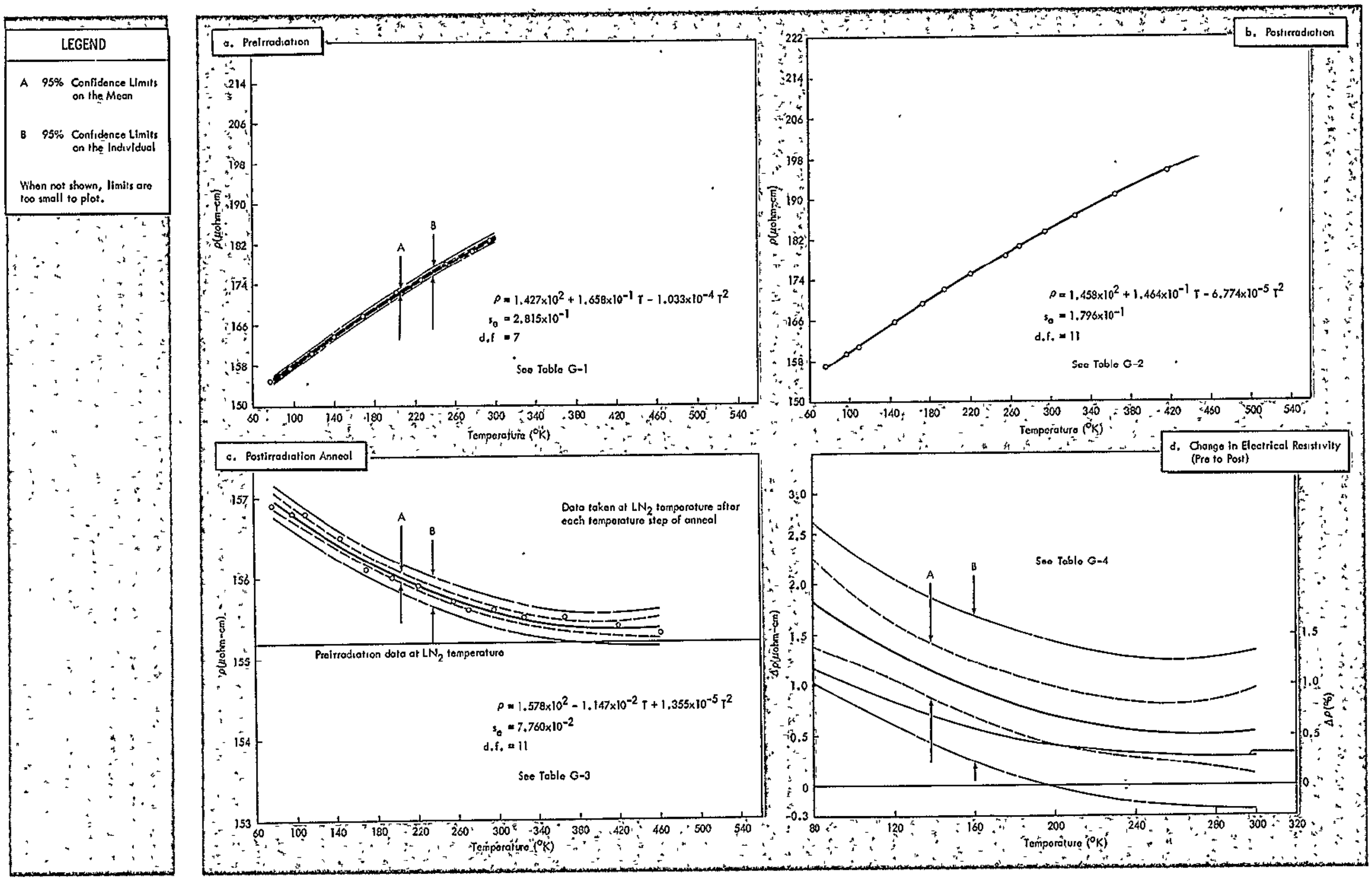

Figure 5-2 Electrical Resistivity of Titanium as a Function of Temperature

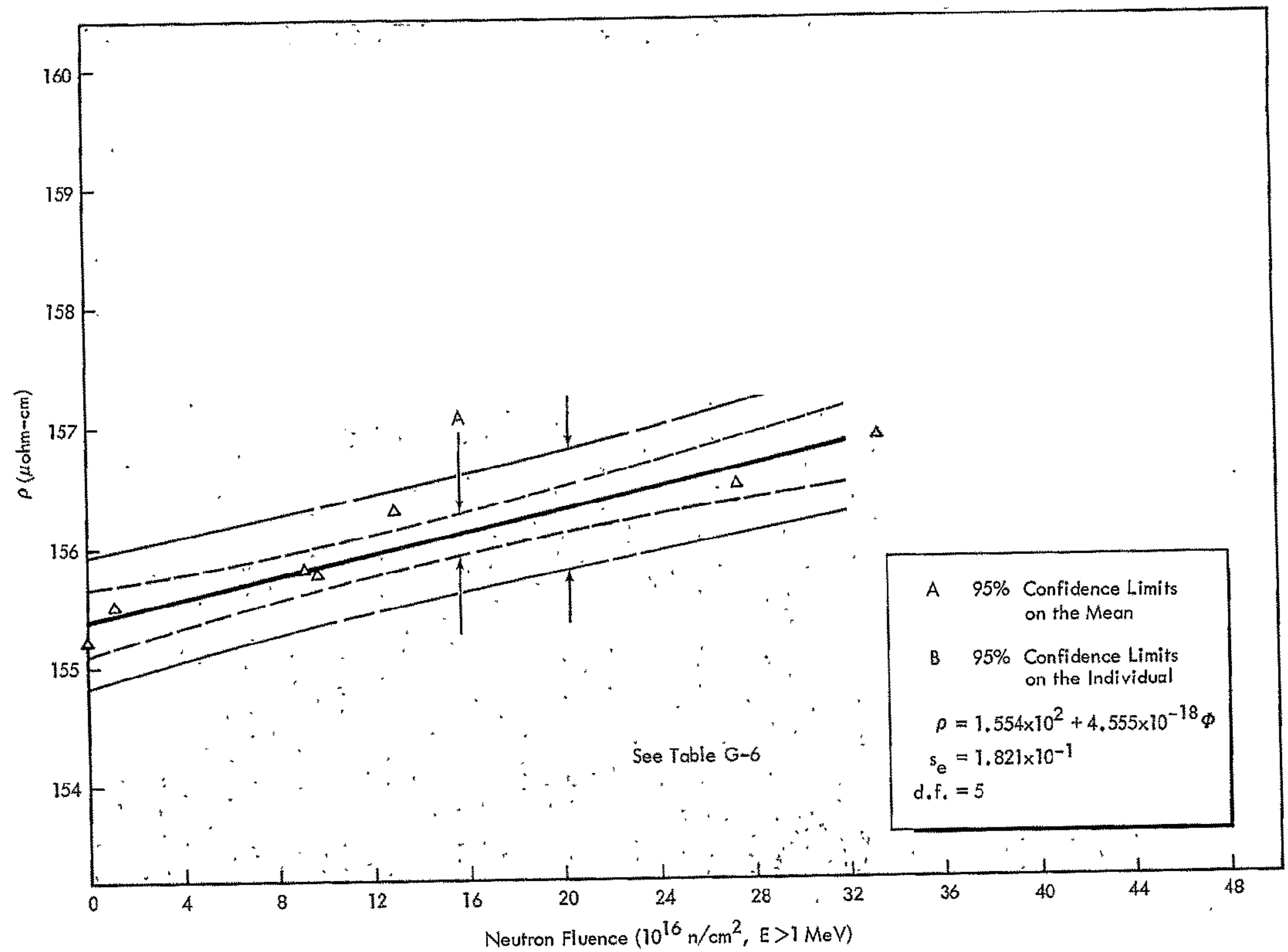

Figure 5-3 Electrical Resistivity of Titanium as a Function of Radiation Exposure at Zero Reactor Power

NPC 27,276

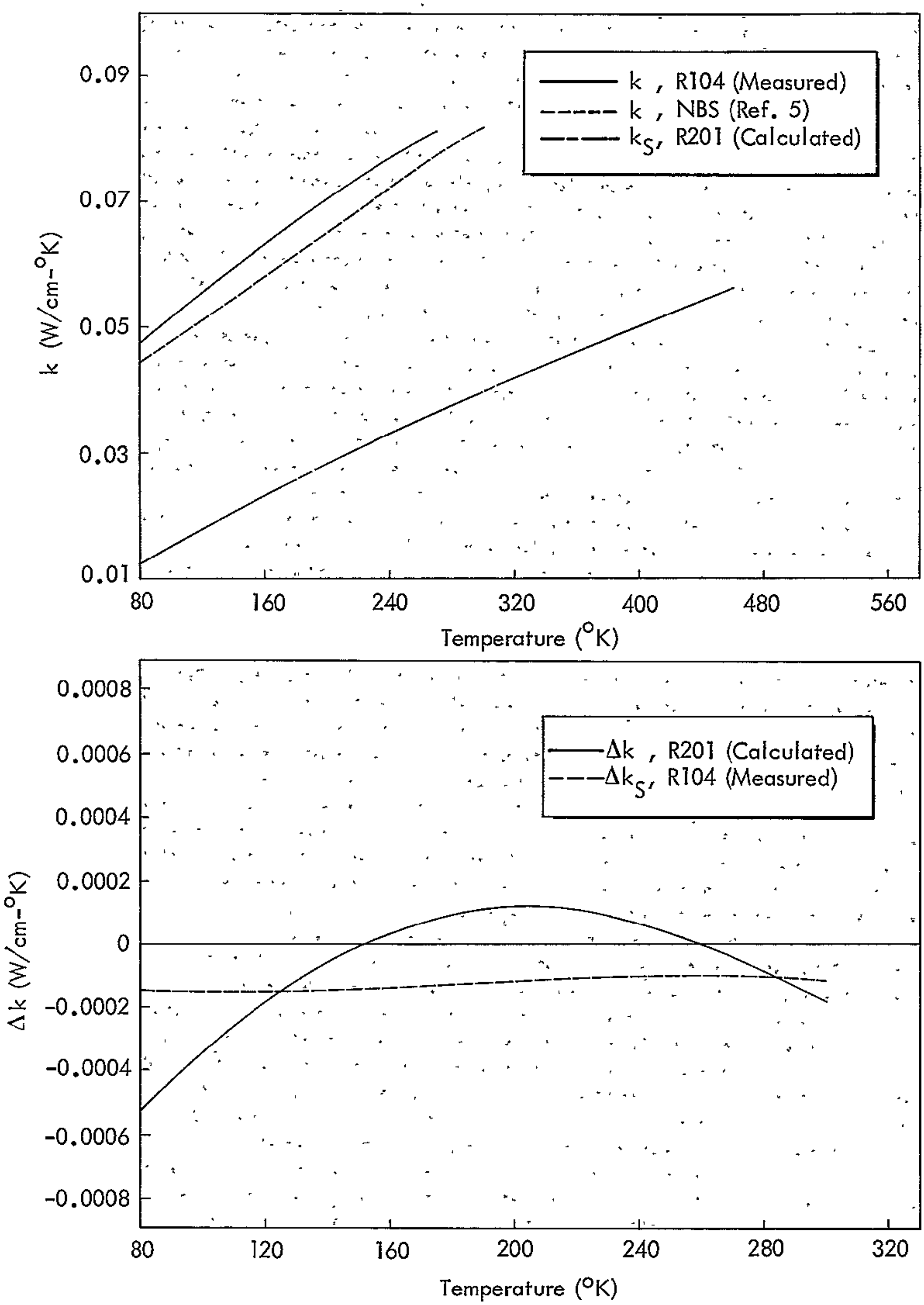

Figure 5-4 Measured and Calculated Thermal Conductivity of Titanium as a Function of Temperature

Table 5-2

ELECTRICAL RESISTIVITY OF TITANIUM BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.5	118.0	141.0	170.0	202.0	226.5	252.5	278.5	295.0				
Avg Resistivity ($\mu\Omega$-cm)	155.2	157.5	160.6	163.8	167.8	172.4	174.9	178.0	180.5	182.7				
No. of Resistivity[a] Measurements	18	6	6	6	5	12	10	6	6	6				
Percent Standard Deviation	0.67	0.15	0.16	0.06	0.11	0.95	0.54	0.05	0.73	0.03				
Thermal Conductivity (watts/cm-°K)	0.0122	0.0150	0.0180	0.0211	0.0248	0.0287	0.0317	0.0348	0.0378	0.0396				
Postirradiation														
Avg Temperature (°K)	77.4	97.5	110.5	145.0	174.0	196.0	221.5	256.5	271.0	296.0	326.0	366.5	419.0	461.0
Avg Resistivity ($\mu\Omega$-cm)	156.9	159.5	160.8	165.7	169.3	172.0	175.0	178.6	180.4	183.4	186.4	190.5	195.2	198.9
No. of Resistivity[a] Measurements	6	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.04	0.11	1.44	0.18	0.07	0.08	0.05	0.27	0.29	0.08	0.08	0.03	0.05	0.05
Thermal Conductivity (watts/cm-°K)	0.0121	0.0150	0.0168	0.0214	0.0252	0.0279	0.0310	0.0352	0.0368	0.0395	0.0428	0.0471	0.0526	0.0568
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	97.5	110.5	145.0	174.0	196.0	221.5	256.5	271.0	296.0	326.0	366.5	419.0	461.0
Avg Resistivity ($\mu\Omega$-cm)	156.9	156.8	156.8	156.5	156.1	156.0	155.9	155.7	155.6	155.7	155.5	155.5	155.7	155.3
No. of Resistivity[a] Measurements	6	4	6	6	6	6	6	5	4	6	6	6	4	3
Percent Standard Deviation	0.04	0.60	0.07	0.04	0.04	0.04	0.04	0.04	0.06	0.04	0.04	0.04	0.32	0.04

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.2 Inconel 718

The data for Inconel 718 are presented in Figures 5-5, 5-6, and 5-7, Table 5-3, and Tables G-7 through G-11 of Appendix G.

Figure 5-5 presents the calculated pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 108.2 μohm-cm at 80°K to 115.6 μohm-cm at 300°K. The postirradiation data range from 108.7 μohm-cm at 80°K to 115.9 μohm-cm at 300°K to 120.6 μohm-cm at 460°K. A change of + 0.5% in ρ at LN_2 temperature was measured with an experimental uncertainty of ± 0.1%. As shown in Figure 5-5(c), no recovery is evident in the postirradiation-anneal at LN_2 temperature.

The electrical resistivity of Inconel 718 at LN_2 temperature increased linearly as a function of neutron fluence. Figure 5-6 shows that an increase of 0.5 μohm-cm at LN_2 temperature had occurred at an exposure of 3.3 x 10^{17} n/cm^2 (E > 1 MeV).

The Wiedemann-Franz Law was used to calculate the thermal conductivity values from both pre- and postirradiation electrical resistivity data as shown in Figure 5-7. In the same figure, measured thermal conductivity data (Ref. 14) have also been plotted. At LN_2 temperature, the calculated k is a factor of 3.4 lower than the measured k.

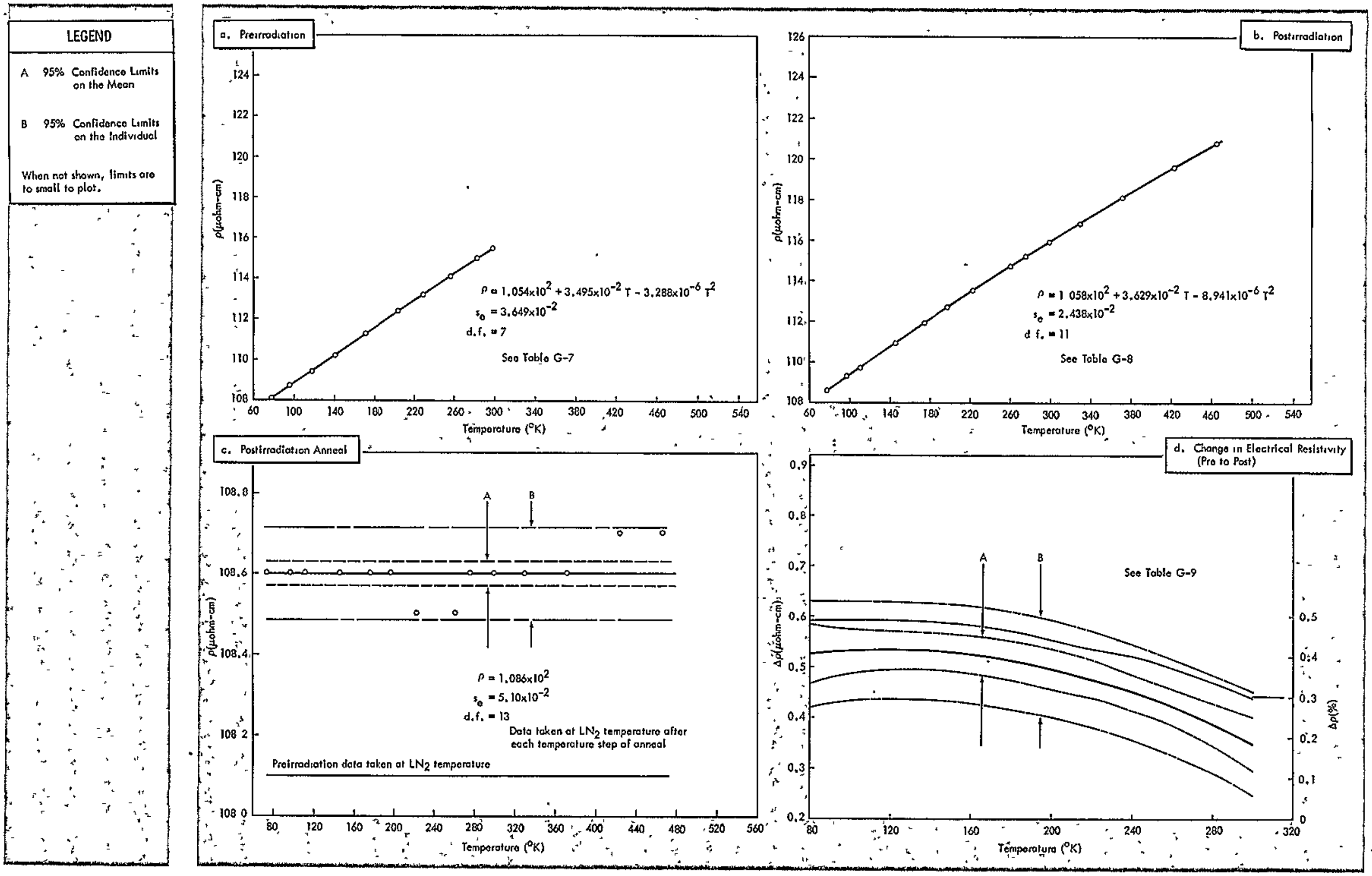

Figure 5-5 Electrical Resistivity of Inconel 718 as a Function of Temperature

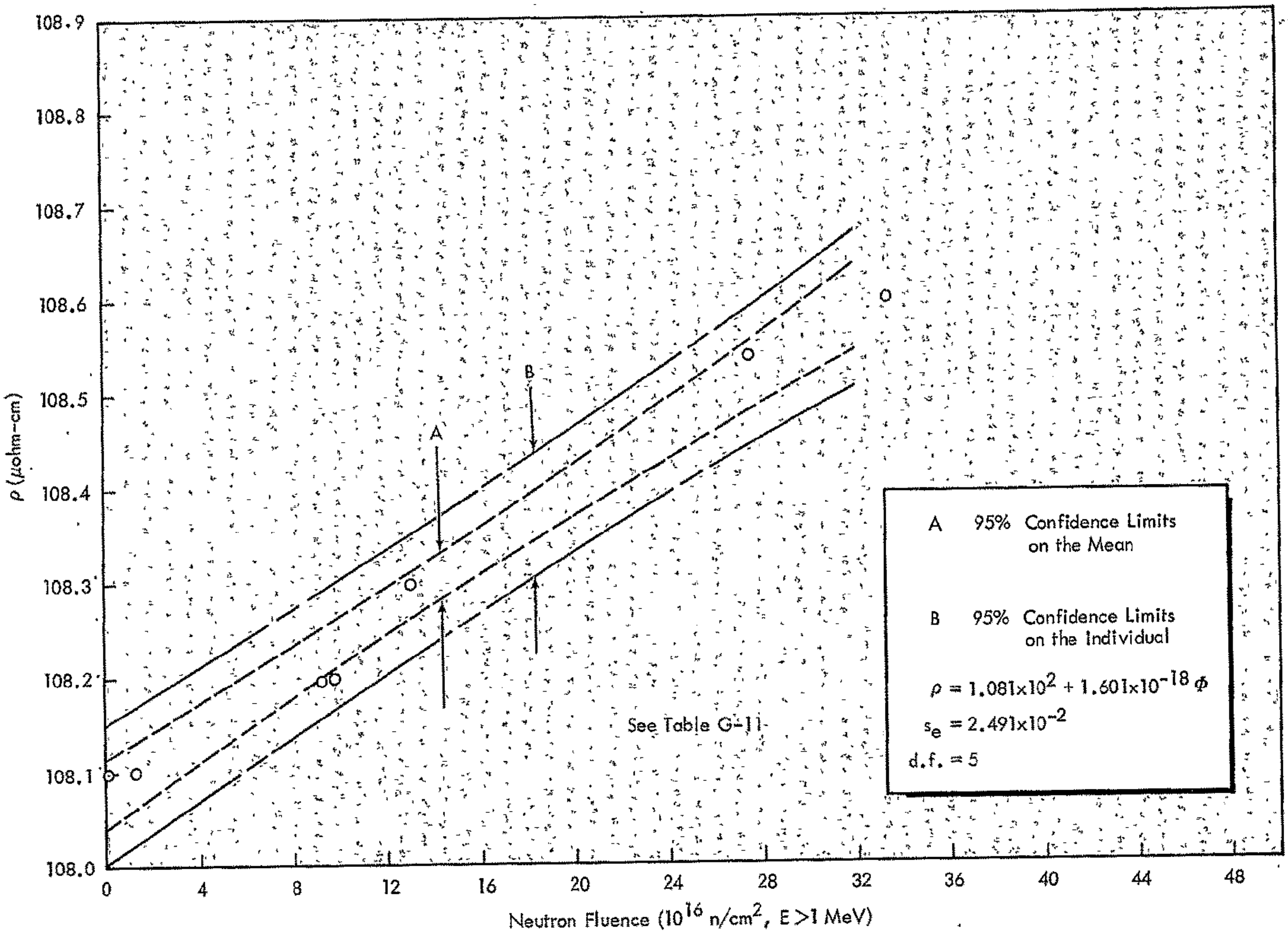

Figure 5-6 Electrical Resistivity of Inconel 718 as a Function of Radiation Exposure at Zero Reactor Power

NPC 27,279

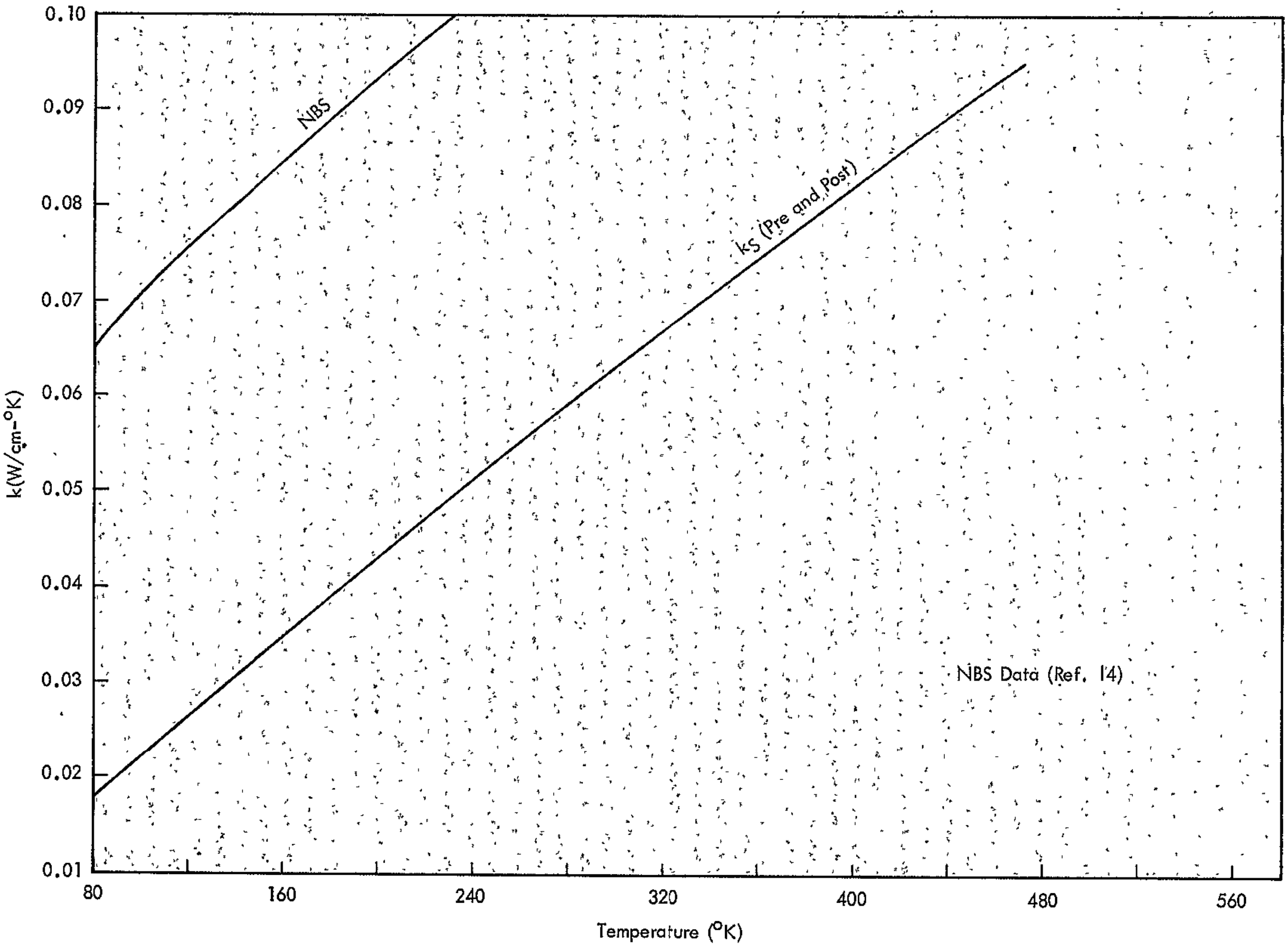

Figure 5-7 Calculated Thermal Conductivity of Inconel 718 as a Function of Temperature

NPC 27,280

Table 5-3

ELECTRICAL RESISTIVITY OF INCONEL 718 BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	118.0	141.0	171.0	204.0	229.0	256.0	282.5	298.5				
Avg Resistivity ($\mu\Omega$-cm)	108.1	108.7	109.4	110.2	111.3	112.4	113.2	114.1	115.0	115.5				
No. of Resistivity[a] Measurements	17	6	6	6	6	12	10	6	6	4				
Percent Standard Deviation	0.05	0.05	0.07	0.05	0.04	0.05	0.04	0.06	0.05	0.00				
Thermal Conductivity (watts/cm-°K)	0.0175	0.0216	0.0264	0.0313	0.0376	0.0445	0.0496	0.0550	0.0602	0.0633				
Postirradiation														
Avg Temperature (°K)	77.4	97.0	110.5	146.0	175.0	198.5	223.5	261.0	276.0	299.5	330.0	372.0	423.5	466.0
Avg Resistivity ($\mu\Omega$-cm)	108.6	109.3	109.7	110.9	111.9	112.7	113.5	114.7	115.2	115.9	116.8	118.1	119.6	120.8
No. of Resistivity[a] Measurements	8	6	6	4	6	6	6	8	6	6	6	6	4	4
Percent Standard Deviation	0.00	0.04	0.04	0.07	0.00	0.00	0.05	0.12	0.04	0.07	0.04	0.03	0.00	0.00
Thermal Conductivity (watts/cm-°K)	0.0175	0.0217	0.0247	0.0323	0.0383	0.0432	0.0482	0.0557	0.0587	0.0633	0.0692	0.0772	0.0868	0.0945
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	97.0	110.5	146.0	175.0	198.5	223.5	261.0	276.0	299.5	330.0	372.0	423.5	466.0
Avg Resistivity ($\mu\Omega$-cm)	108.6	108.6	108.6	108.6	108.6	108.6	108.5	108.5	108.6	108.6	108.6	108.6	108.7	108.7
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.00	0.00	1.22	0.00	0.04	0.04	0.08	0.05	0.05	0.04	0.04	0.00	0.00	0.04

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.3 Hastelloy X

The data for Hastelloy X are presented in Figures 5-8, 5-9, and 5-10, Table 5-4, and Tables G-12 through G-15 of Appendix G.

Figure 5-8 presents the calculated pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data ranged from 108.9 μohm-cm at 80°K to 115.0 μohm-cm at 300°K. The postirradiation data ranged from 108.9 μohm-cm at 80°K to 115.0 μohm-cm at 300°K to 118.8 μohm-cm at 460°K. No change in electrical resistivity was indicated in this specimen. Figure 5-9 is a plot of the electrical resistivity as a function of radiation exposure at zero reactor power and shows essentially no change in ρ.

Figure 5-10 presents the thermal conductivity data calculated using the pre- and postirradiation electrical resistivity data. In the same figure, measured thermal conductivity data (Ref. 14) have also been plotted. At LN_2 temperature, the calculated data are a factor of 3.5 lower than the measured data.

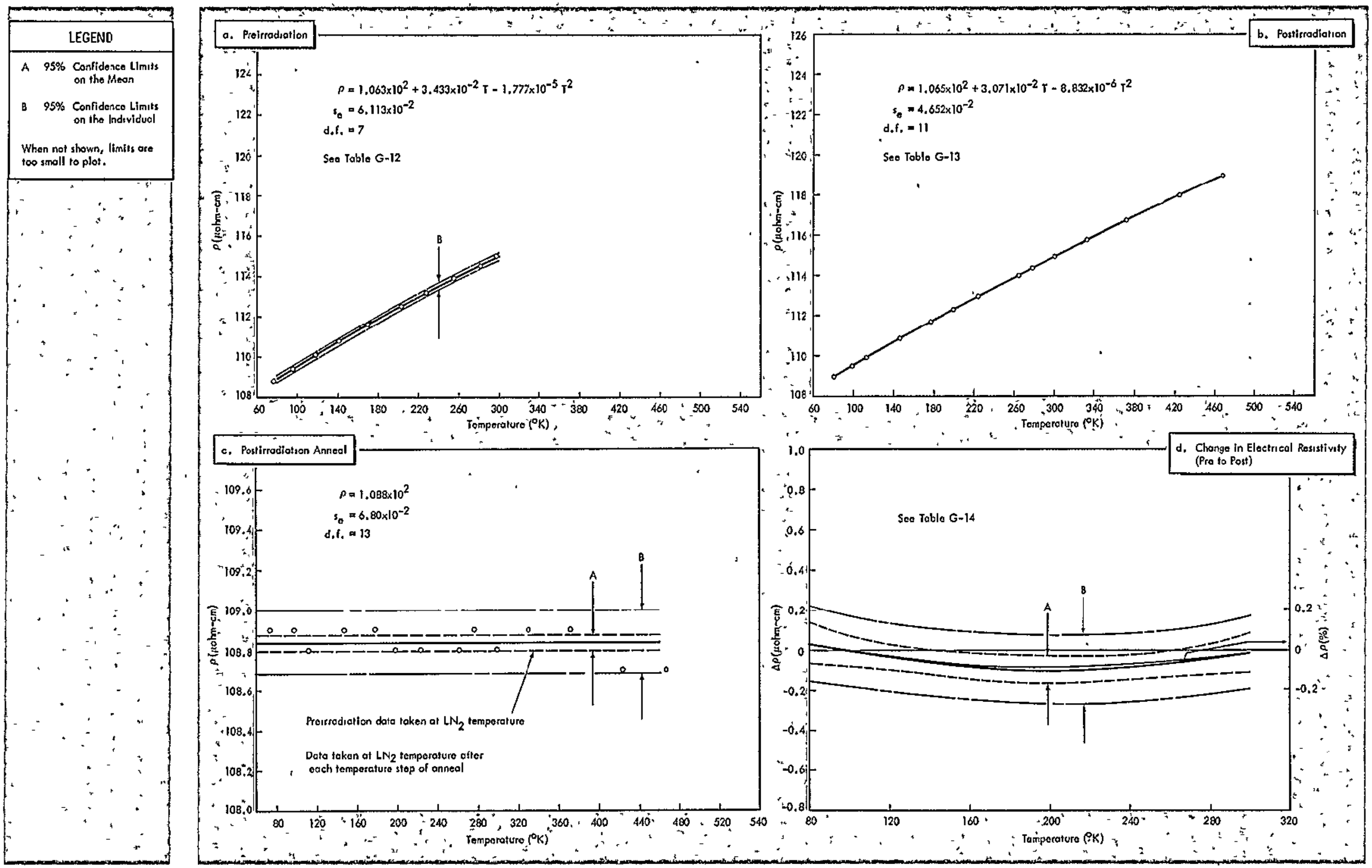

Figure 5-8 Electrical Resistivity of Hastelloy X as a Function of Temperature

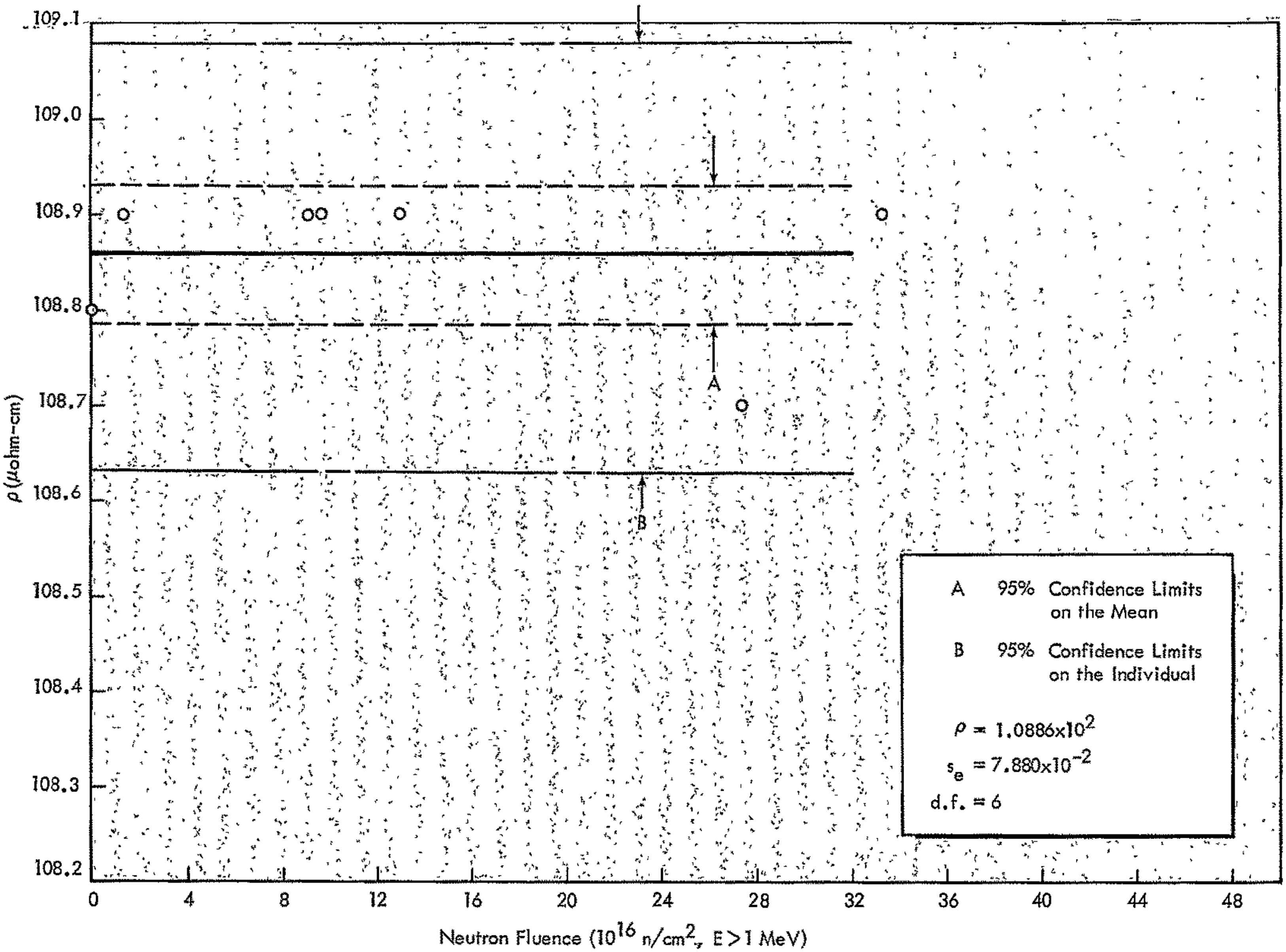

Figure 5-9 Electrical Resistivity of Hastelloy X as a Function of Radiation Exposure at Zero Reactor Power

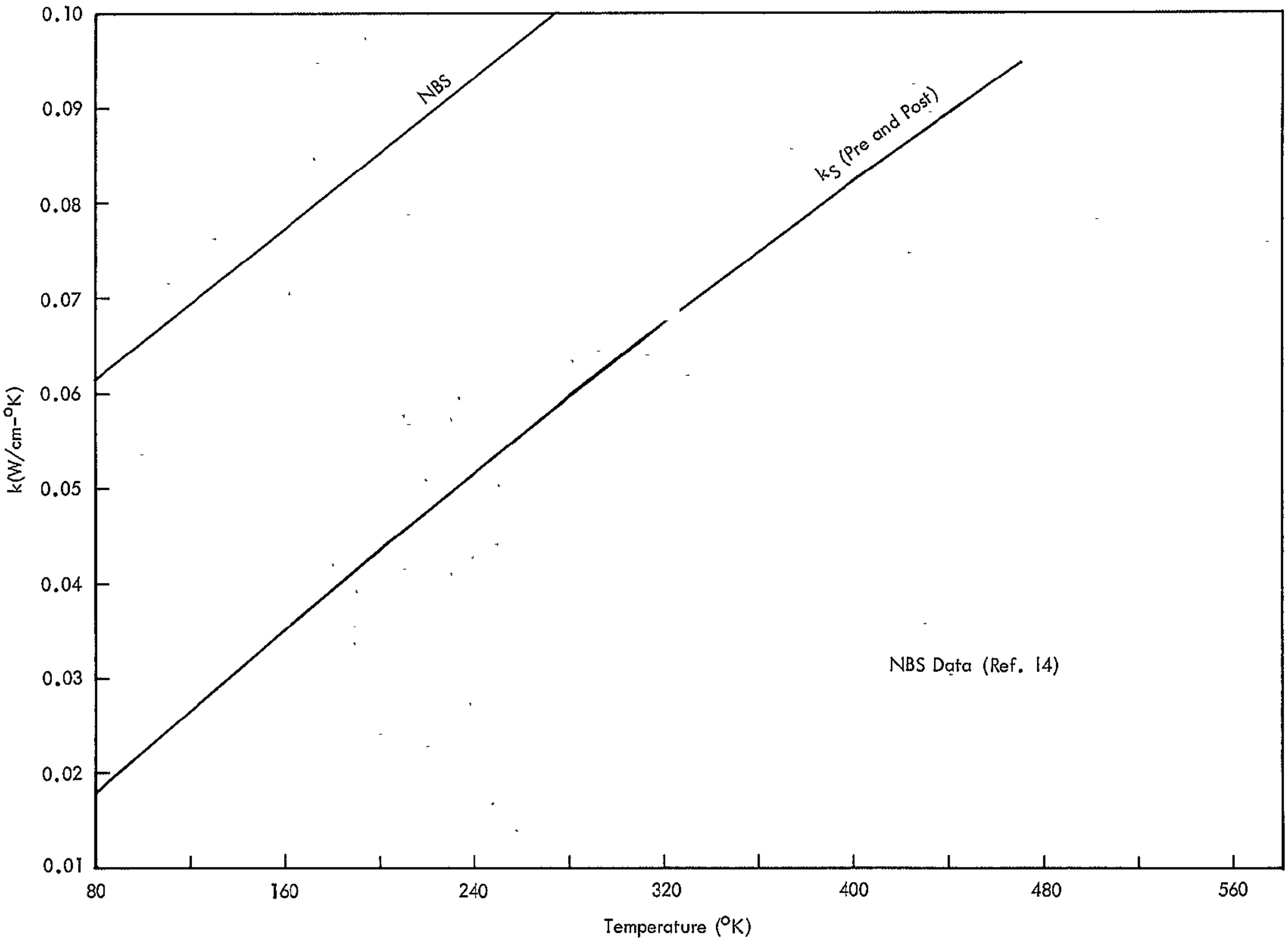

Figure 5-10 Calculated Thermal Conductivity of Hastelloy X as a Function of Temperature

NPC 27,283

Table 5-4

ELECTRICAL RESISTIVITY OF HASTELLOY X BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	118.5	141.5	170.5	203.5	228.5	255.5	281.5	297.5				
Avg Resistivity ($\mu\Omega$-cm)	108.8	109.4	110.1	110.8	111.6	112.5	113.2	113.9	114.4	115.0				
No. of Resistivity[a] Measurements	17	5	6	6	6	11	10	6	6	6				
Percent Standard Deviation	0.25	0.04	0.05	0.05	0.07	0.10	0.04	1.17	0.32	0.04				
Thermal Conductivity (watts/cm-°K)	0.0174	0.0215	0.0264	0.0313	0.0374	0.0443	0.0495	0.0550	0.0603	0.0634				
Postirradiation														
Avg Temperature (°K)	77.4	97.0	110.5	145.5	175.0	198.5	223.0	261.5	276.0	299.5	330.5	372.0	423.5	466.5
Avg Resistivity ($\mu\Omega$-cm)	108.9	109.4	109.8	110.8	111.6	112.3	113.0	114.0	114.4	114.9	115.7	116.7	117.9	119.0
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.00	0.05	0.00	0.00	0.04	0.04	0.04	0.08	0.04	0.04	0.00	0.00	0.00	0.00
Thermal Conductivity (watts/cm-°K)	0.0174	0.0217	0.0247	0.0322	0.0384	0.0433	0.0483	0.0562	0.0591	0.0639	0.0700	0.0781	0.0868	0.0946
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	97.0	110.5	145.5	175.0	198.5	223.0	261.5	276.0	299.5	330.5	372.0	423.5	466.5
Avg Resistivity ($\mu\Omega$-cm)	108.9	108.9	108.8	108.9	108.9	108.8	108.8	108.8	108.9	108.8	108.9	108.9	108.7	108.7
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.00	0.07	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.04	0.00	0.04	0.00	0.05

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.4 Graphite PO-3

The data for PO-3 graphite are presented in Figures 5-11 and 5-12, Table 5-5, and Tables G-16 through G-21 of Appendix G.

Figure 5-11 presents the calculated pre- and postirradiation and postirradiation-anneal electrical resistivity, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 2139 μohm-cm at 80^{o}K to 2119 μohm-cm at 120^{o}K. The postirradiation data range from 3543 μohm-cm at 80^{o}K to 3382 μohm-cm at 120^{o}K to 1488 μohm-cm at 460^{o}K.

Several irregularities can be noted in the graphite data. As can be seen in Table 5-5, only three preirradiation points could be determined. However, the data obtained during and after irradiation seems to be reliable. At the beginning of the test it was doubtful that any meaningful data could be obtained with the graphite specimen. It was necessary to modify the base plate of the electrical resistivity assembly in order to eliminate ground loops. In the process of this modification, the graphite specimen was broken at the point of its connection to the base plate. Because of limited time before the scheduled irradiation and the possibility of breaking the specimen again, it was decided not to rethread the specimen into the plate as it was originally.

A fix was made by jumpering the common current connection

to the bottom of the graphite specimen. This resulted in the graphite being supported only by the electrical leads that were attached to it. After sliding the electrical heater over the resistivity test assembly and then mounting it to the lid of the cryogenic box, it was found that the measured voltage varied erratically when the current was applied. As there was then insufficient time to correct the problem without delaying the entire test, the graphite specimen was left as it was. It is believed that the non-rigid mounting of the specimen allowed it to become intermittently in contact with some part of the fixture, thus partially shorting the specimen. In this condition the measured voltage would be low, but never too high. This problem did not occur when the specimens were immersed in LN_2.

The change in electrical resistivity at LN_2 temperatures was approximately +44% with an experimental uncertainty of $\pm$19.6%. This uncertainty is due to the large uncertainty in the preirradiation data. After heating the specimen to 460°K and subsequently cooling to LN_2 temperature, the electrical resistivity had recovered to within 10% of its initial preirradiation as shown in Figure 5-11(d).

Figure 5-12 shows that the electrical resistivity during irradiation, at LN_2 temperature, increased nonlinearly as a function of neutron fluence from 2364 μohm-cm to 3410 μohm-cm at an exposure of 3.3×10^{17} n/cm^2 (E > 1 MeV).

The thermal conductivity of graphite was not calculated. It was noted in Section III that the thermal conductivity of graphite is probably dominated by the lattice component; thus, the Wiedemann-Franz Law would not be applicable.

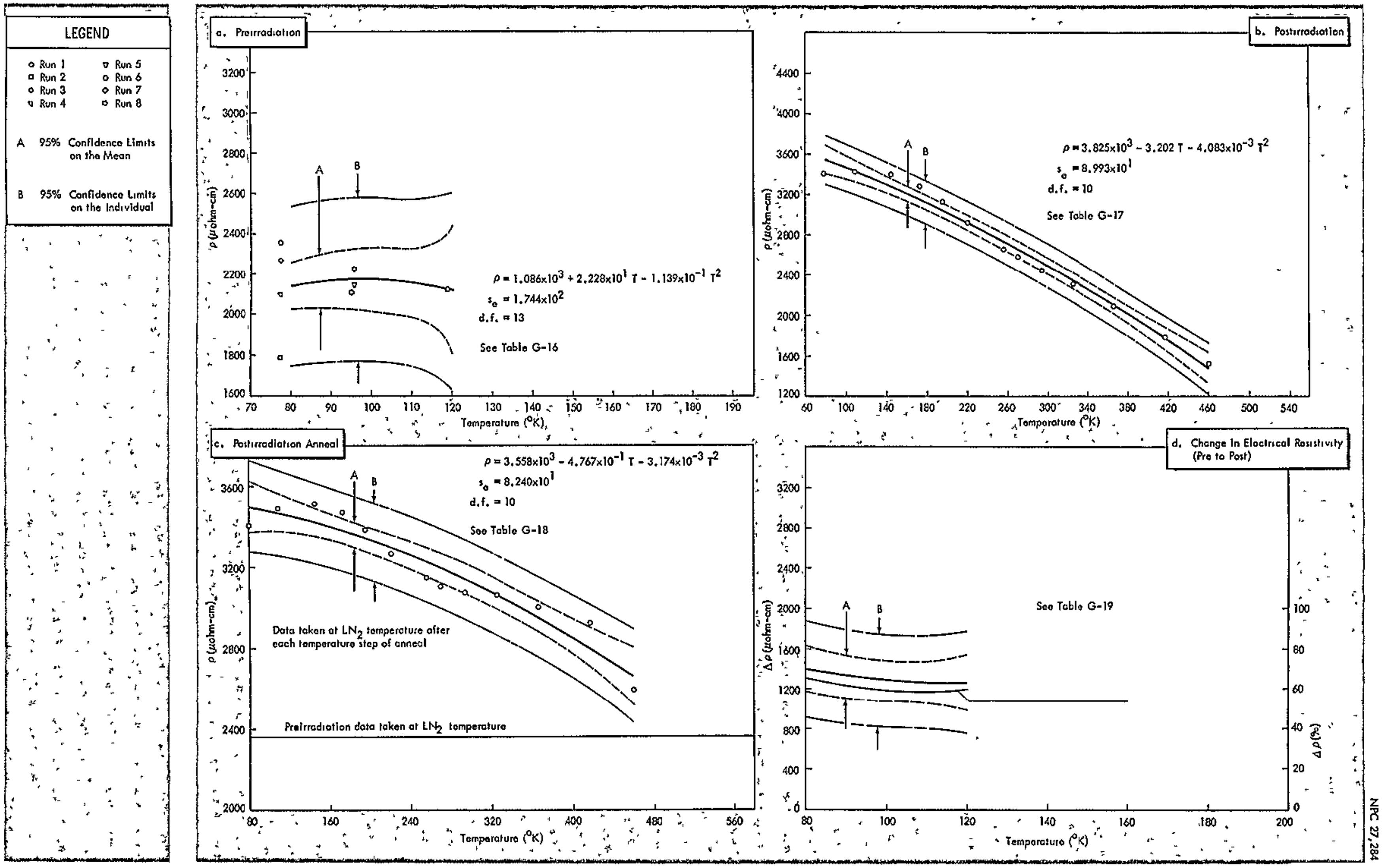

Figure 5-11 Electrical Resistivity of Graphite as a Function of Temperature

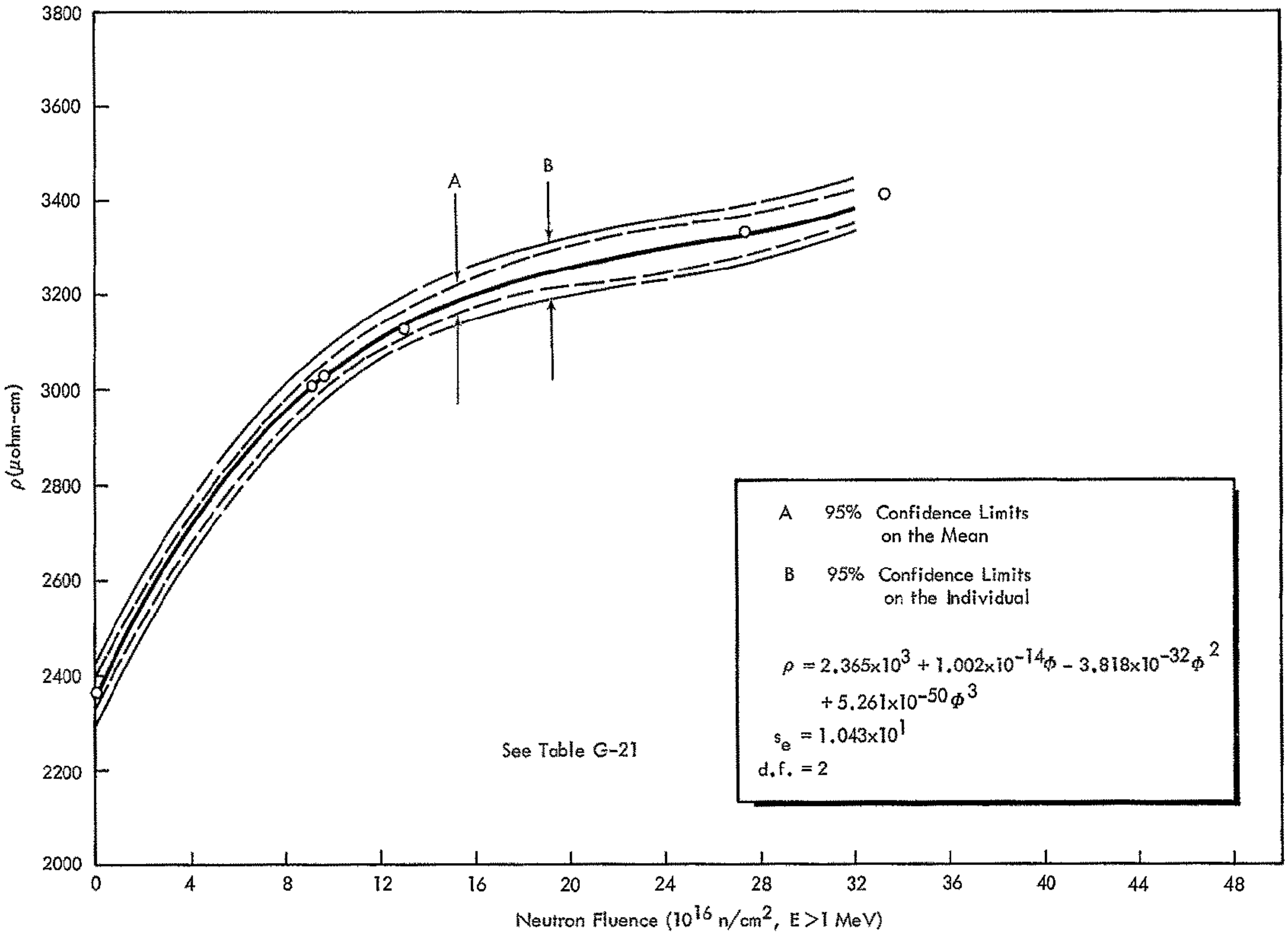

Figure 5-12 Electrical Resistivity of Graphite as a Function of Radiation Exposure at Zero Reactor Power

Table 5-5

ELECTRICAL RESISTIVITY OF GRAPHITE BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	118.0											
Avg Resistivity ($\mu\Omega$-cm)	2364	2175	2127											
No. of Resistivity[a] Measurements	8	6	2											
Postirradiation														
Avg Temperature (°K)	77.4	95.0	109.0	145.0	173.5	195.5	221.0	256.5	270.5	294.5	325.5	366.0	417.0	460.0
Avg Resistivity ($\mu\Omega$-cm)	3409	2362	3427	3396	3283	3127	2922	2663	2585	2453	2321	2097	1790	1535
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	8	6	6	6	6	4	2
Percent Standard Deviation	0.14	0.86	0.06	0.06	0.27	0.42	0.63	1.08	0.29	0.32	0.39	0.86	0.63	0.00
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	95.0	109.0	145.0	173.5	195.5	221.0	256.5	270.5	294.5	325.5	366.0	417.5	460.0
Avg Resistivity ($\mu\Omega$-cm)	3409	3369	3493	3512	3472	3386	3268	3150	3116	3079	3061	3010	2927	2593
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.14	1.01	0.21	0.24	0.08	0.00	0.00	0.04	0.04	0.00	0.00	0.17	0.02	0.09

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.5 Inconel*

The data for Inconel* are presented in Figures 5-13, 5-14, and 5-15, Table 5-6, and Tables G-22 through G-26 of Appendix G.

Figure 5-13 presents the calculated pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 120.8 μohm-cm at 80^{o}K to 124.1 μohm-cm at 300^{o}K. The postirradiation data range from 120.9 μohm-cm at 80^{o}K to 124.1 μohm-cm at 300^{o}K to 126.9 μohm-cm at 460^{o}K. The change in electrical resistivity at LN_2 temperature is approximately + 0.1%, which is the same as the experimental uncertainty of these data and is therefore considered to be insignificant.

The postirradiation-anneal data at LN_2 temperature was essentially constant up to 330^{o}K as shown in Figure 5-13(d). However, after increasing the temperature to 460^{o}K, the electrical resistivity increased above the LN_2 preirradiation value. The reason for this behavior is not known.

The electrical resistivity as a function of radiation exposure at zero reactor power shown in Figure 5-14 is constant.

Figure 5-15 presents the thermal conductivity data calculated using the pre- and postirradiation electrical resistivity data. Since the type of Inconel is unknown, no comparison to measured thermal conductivity can be made.

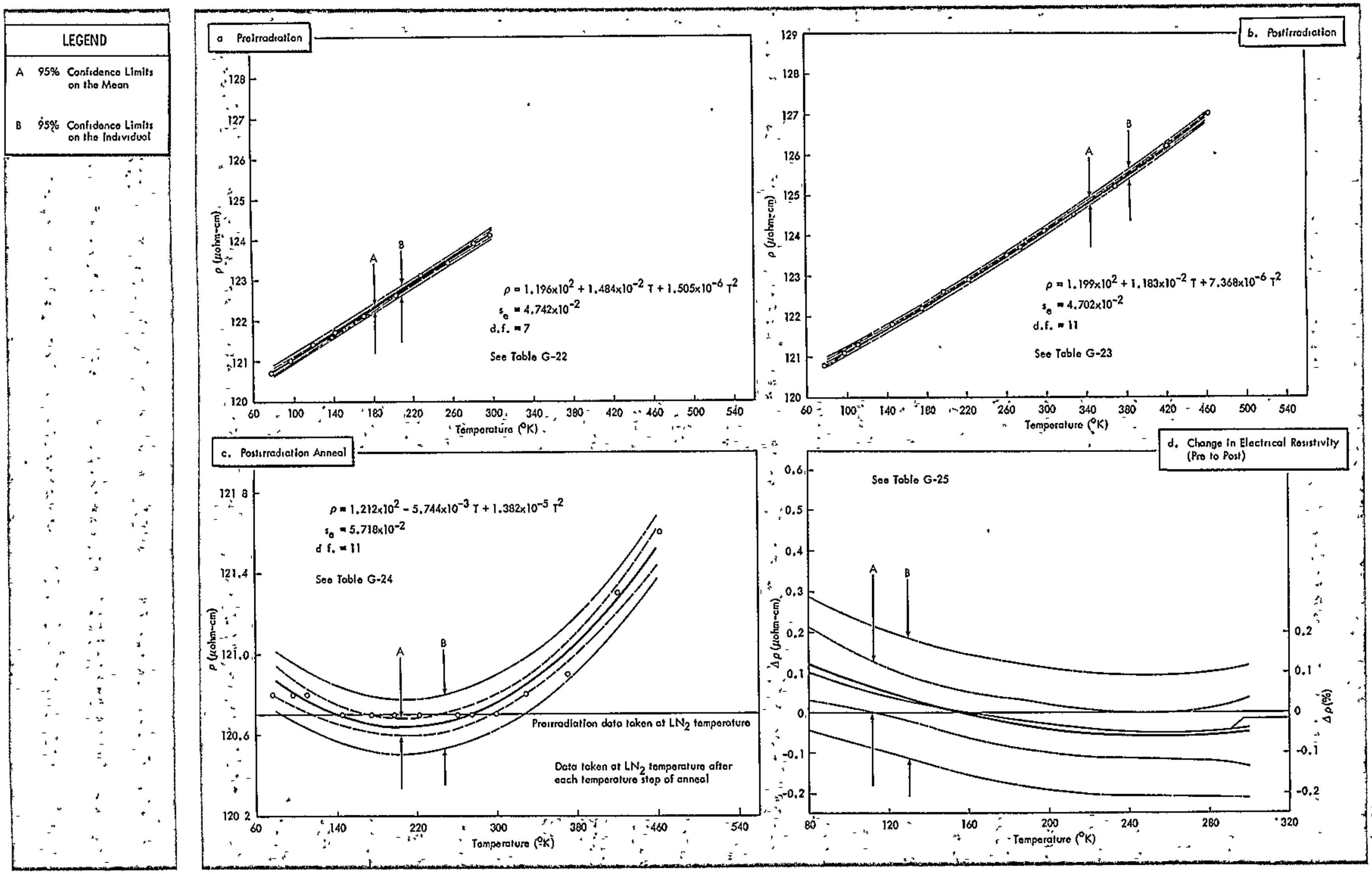

Figure 5-13 Electrical Resistivity of Inconel* as a Function of Temperature

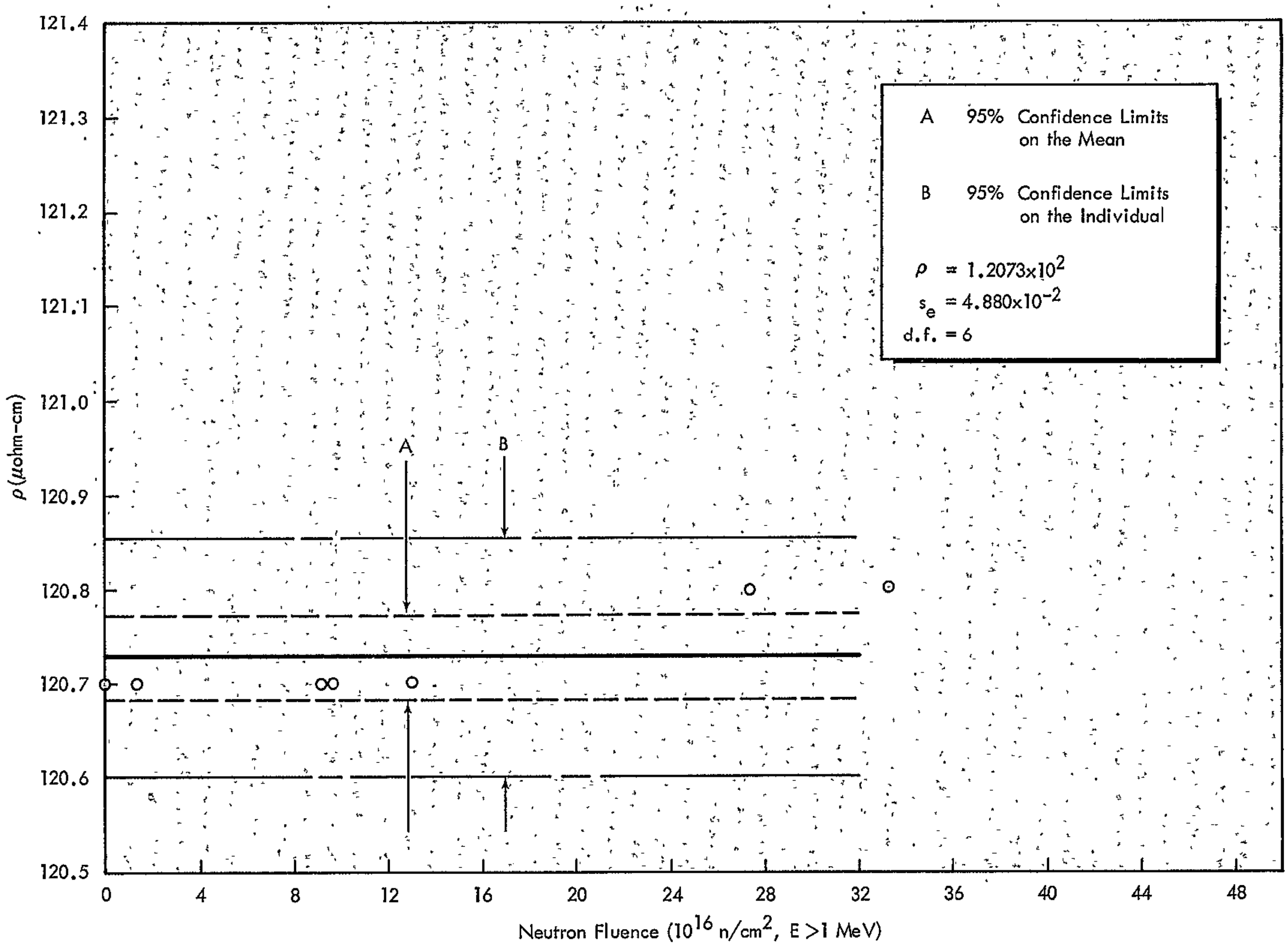

Figure 5-14 Electrical Resistivity of Inconel* as a Function of Radiation Exposure at Zero Reactor Power

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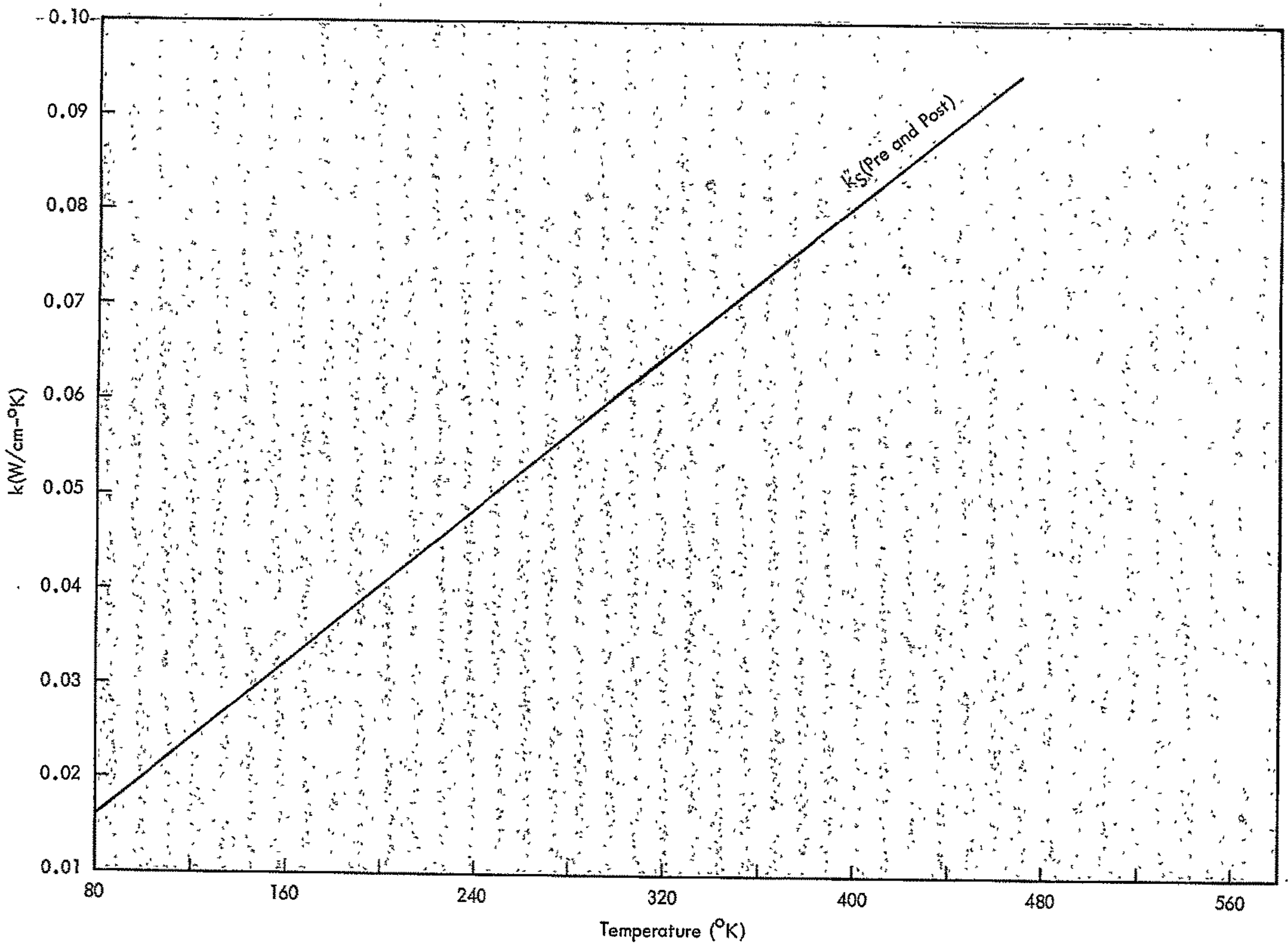

Figure 5-15 Calculated Thermal Conductivity of Inconel* as a Function of Temperature

NPC 27,288

Table 5-6

ELECTRICAL RESISTIVITY OF INCONEL* BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.5	119.0	141.5	170.5	203.5	228.5	255.5	281.5	298.0				
Avg Resistivity (μΩ-cm)	120.7	121.0	121.4	121.7	122.1	122.6	123.1	123.4	123.9	124.1				
No. of Resistivity[a] Measurements	18	6	6	6	6	12	10	6	6	6				
Percent Standard Deviation	0.02	0.00	0.04	0.00	0.03	0.04	0.04	0.04	0.03	0.00				
Thermal Conductivity (watts/cm-°K)	0.0157	0.0195	0.0240	0.0285	0.0342	0.0407	0.0455	0.0507	0.0557	0.0588				
Postirradiation														
Avg Temperature (°K)	77.4	97.5	111.5	146.0	175.5	198.5	223.5	261.5	275.0	299.0	329.0	370.5	421.5	463.5
Avg Resistivity (μΩ-cm)	120.8	121.1	121.3	121.8	122.2	122.6	122.9	123.5	123.7	124.1	124.5	125.2	126.2	127.0
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.04	0.00	0.03	0.04	0.00	0.04	0.00	0.05	0.03	0.04	0.00	0.03	0.04	0.04
Thermal Conductivity (watts/cm-°K)	0.0157	0.0197	0.0225	0.0294	0.0352	0.0397	0.0446	0.0519	0.0545	0.0590	0.0647	0.0725	0.0818	0.0894
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	97.5	111.5	146.0	175.5	198.5	223.5	261.5	275.0	299.0	329.0	370.5	421.5	463.5
Avg Resistivity (μΩ-cm)	120.8	120.8	120.8	120.7	120.7	120.7	120.7	120.7	120.7	120.7	120.8	120.9	121.3	121.6
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.04	0.03	0.04	0.04	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.04	0.04

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.6 Aluminum 7039-T61(1)

The data for Aluminum 7039-T61(1) are presented in Figures 5-16, 5-17, and 5-18, Table 5-7, and Tables G-27 through G-32 of Appendix G.

Figure 5-16 presents the calculated pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 2.238 μohm-cm at 80^{o}K to 4.860 μohm-cm at 300^{o}K. The postirradiation data range from 2.326 at 80^{o}K to 4.834 μohm-cm at 300^{o}K to 6.719 μohm-cm at 460^{o}K. A change in electrical resistivity at LN_2 temperature of approximately + 6.0% with an experimental uncertainty of $\pm$ 2.6% was observed. The postirradiation-anneal data indicated that the specimen had completely annealed at approximately 360^{o}K. Annealing temperatures up to 460^{o}K resulted in a ρ of 2.128 μohm-cm, which is approximately 9% below the initial preirradiation value of 2.337 μohm-cm. This is probably because the higher annealing temperatures resulted in property changes in the material.

The electrical resistivity during irradiation (see Figure 5-17) increased linearly as a function of neutron fluence at LN_2 temperature from 2.16 to 2.29 μohm-cm at 3.3 x 10^{17} n/cm^2 (E > 1 MeV).

Figure 5-17(a & b) presents the thermal conductivity data

calculated using the pre- and postirradiation electrical resistivity data. Figure 5-17(c) is a comparison of the preirradiation data, including the Aluminum 7039-T61(2) specimen, with the preirradiation data from the 37/R104 test (Sec. III) and NBS data (Ref. 8). Figure 5-17(d) is a comparison of the change in thermal conductivity. The thermal conductivity data of Al 7039-T61(1) and the 37/R104 agree within 4% up to 180^{o}K.

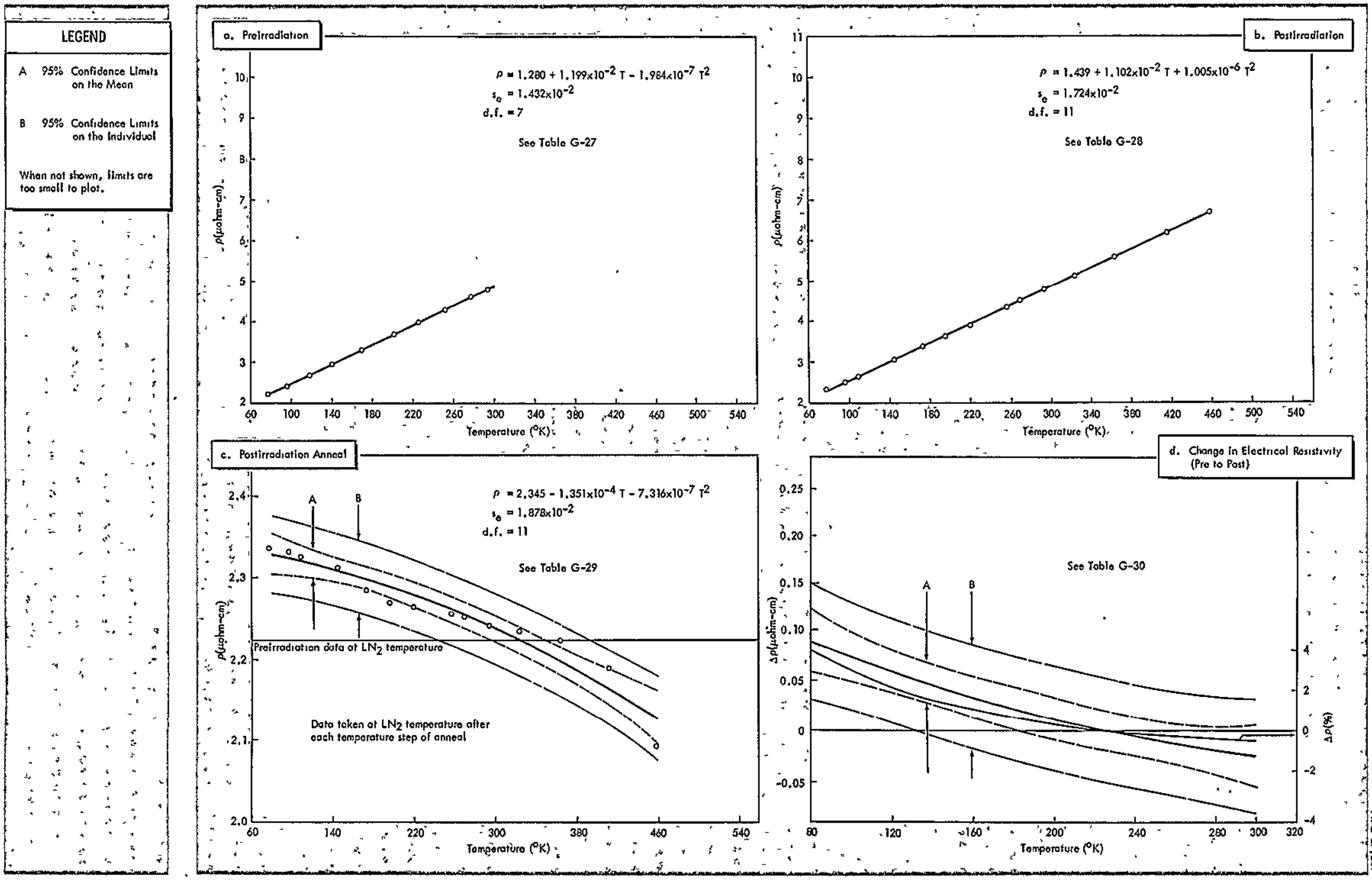

Figure 5-16 Electrical Resistivity of Aluminum 7039-T61(1) as a Function of Temperature

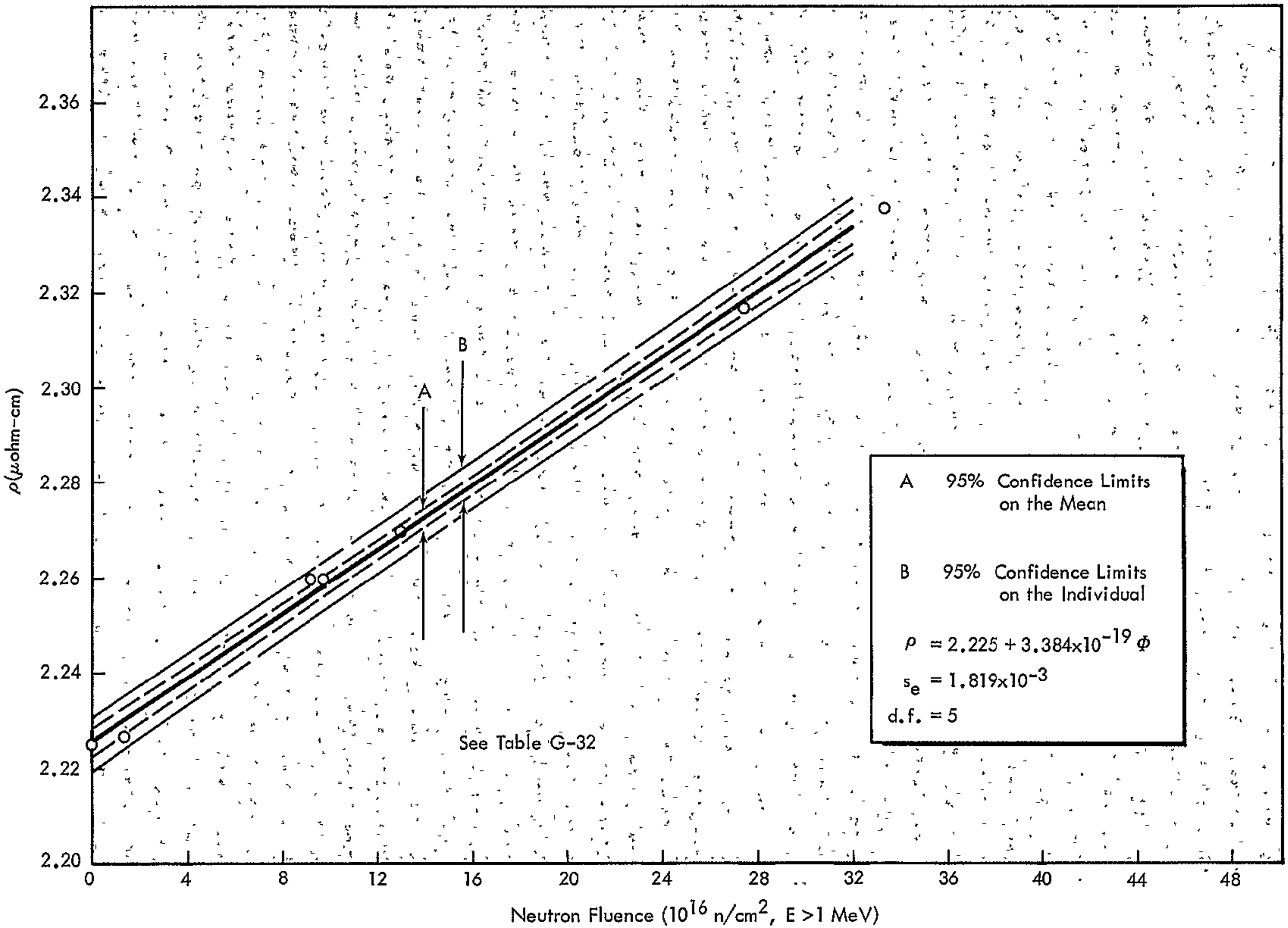

Figure 5-17 Electrical Resistivity of Aluminum 7039-T61(1) as a Function of Radiation Exposure at Zero Reactor Power

NPC 27,290

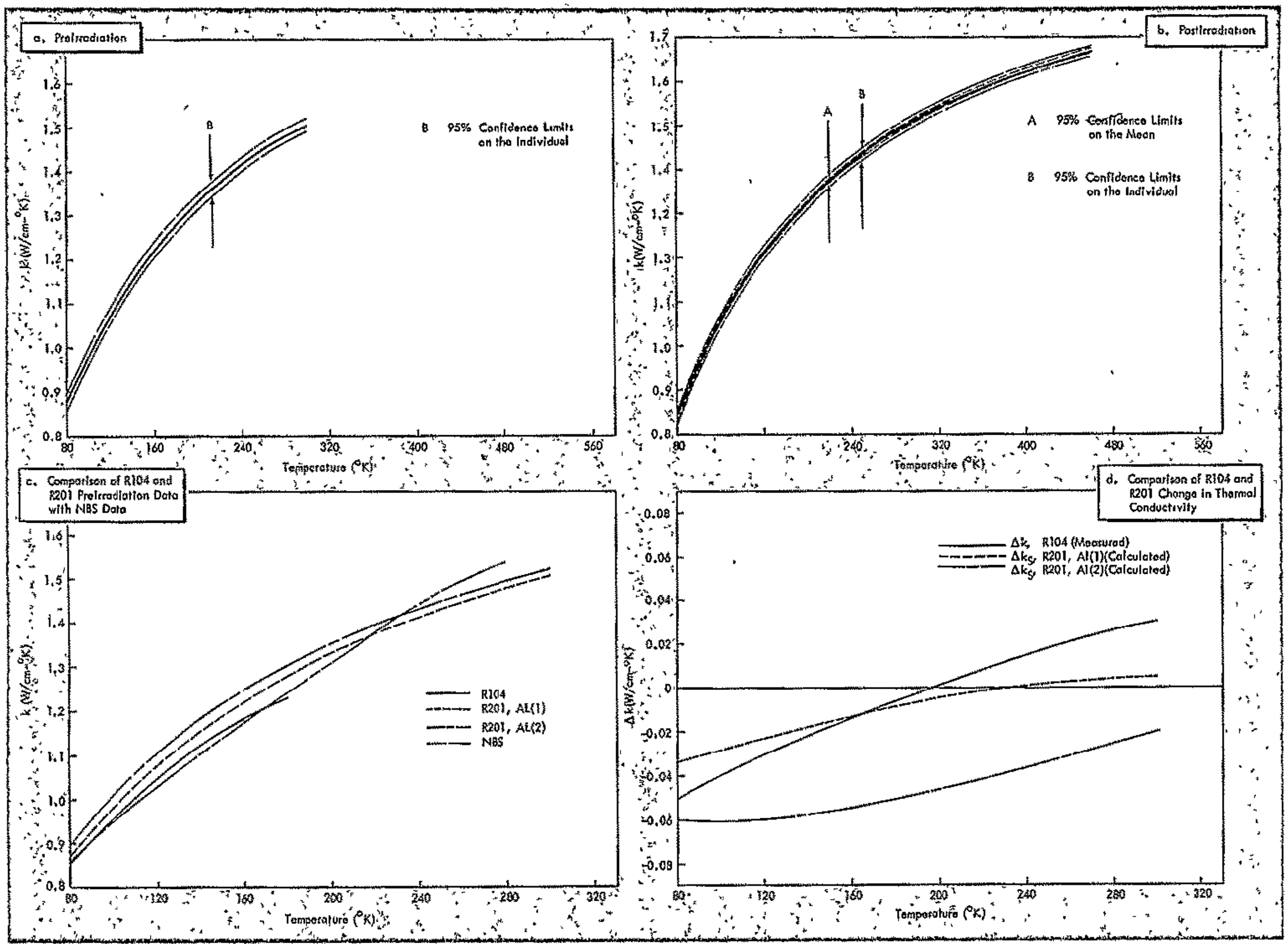

Figure 5-18 Measured and Calculated Thermal Conductivity of Aluminum 7039-T61(1) as a Function of Temperature

Table 5-7

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1) BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	118.5	140.5	169.5	201.5	225.5	252.0	277.5	294.0				
Avg Resistivity ($\mu\Omega$-cm)	2.225	2.423	2.684	2.951	3.307	3.689	3.984	4.299	4.605	4.768				
No. of Resistivity[a] Measurements	18	6	6	6	6	12	8	6	6	8				
Percent Standard Deviation	0.08	0.33	0.35	0.17	0.20	0.47	0.16	0.49	0.02	0.64				
Thermal Conductivity (watts/cm-°K)	0.852	0.971	1.082	1.167	1.256	1.338	1.387	1.436	1.476	1.511				
Postirradiation														
Avg Temperature (°K)	77.4	96.5	109.5	144.5	173.5	196.0	220.5	257.5	270.0	294.0	324.5	364.5	416.5	458.5
Avg Resistivity ($\mu\Omega$-cm)	2.337	2.497	2.635	3.043	3.376	3.624	3.909	4.352	4.503	4.773	5.125	5.592	6.187	6.703
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	8	5	6	6	6	4	4
Percent Standard Deviation	0.04	0.33	0.44	0.55	0.27	0.07	0.13	0.87	0.11	0.16	0.16	0.23	0.03	0.05
Thermal Conductivity (watts/cm-°K)	0.811	0.947	1.018	1.163	1.259	1.325	1.382	1.450	1.469	1.509	1.551	1.597	1.649	1.676
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	96.5	109.5	144.5	173.5	196.0	220.5	257.5	270.0	294.0	324.5	364.5	416.5	458.5
Avg Resistivity ($\mu\Omega$-cm)	2.337	2.333	2.327	2.313	2.286	2.270	2.265	2.258	2.253	2.243	2.236	2.224	2.190	2.093
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.04	0.07	0.06	0.03	0.04	0.09	0.09	0.05	0.05	0.06	0.03	0.03	0.06	0.11

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.7 Aluminum 7039-T61(2)

The data for Aluminum 7039-T61(2) are presented in Figures 5-19, 5-20, and 5-21, Table 5-8, and Tables G-33 through G-38 of Appendix G.

Figure 5-19 presents the calculated pre- and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 2.174 μohm-cm at 80°K to 4.815 μohm-cm at 300°K. The postirradiation data range from 2.330 μohm-cm at 80°K to 4.878 μohm-cm at 300°K to 6.668 μohm-cm at 460°K. A change in electrical resistivity at LN_2 temperature of approximately +5.0% with an experimental uncertainty of ±1.7% was observed. The post-irradiation-anneal data indicate that complete annealing had taken place at approximately 360°K. The electrical resistivity continued to decrease, as in the case of specimen 1, below the initial preirradiation value. After reaching an annealing temperature of 460°K, the electrical resistivity at LN_2 temperature was 2.107 μohm-cm, or approximately 8% below the initial value of 2.291 μohm-cm.

In Figure 5-20, the electrical resistivity increased linearly at LN_2 temperature from 2.22 to 2.33 μohm-cm as a function of neutron fluence when exposed to 3.3×10^{17} n/cm^2 (E > 1 MeV).

Figure 5-21 presents the thermal conductivity calculated

using the pre- and postirradiation electrical resistivity data. A comparison of the preirradiation and change in thermal conductivity data was presented in Figure 5-17(c & d).

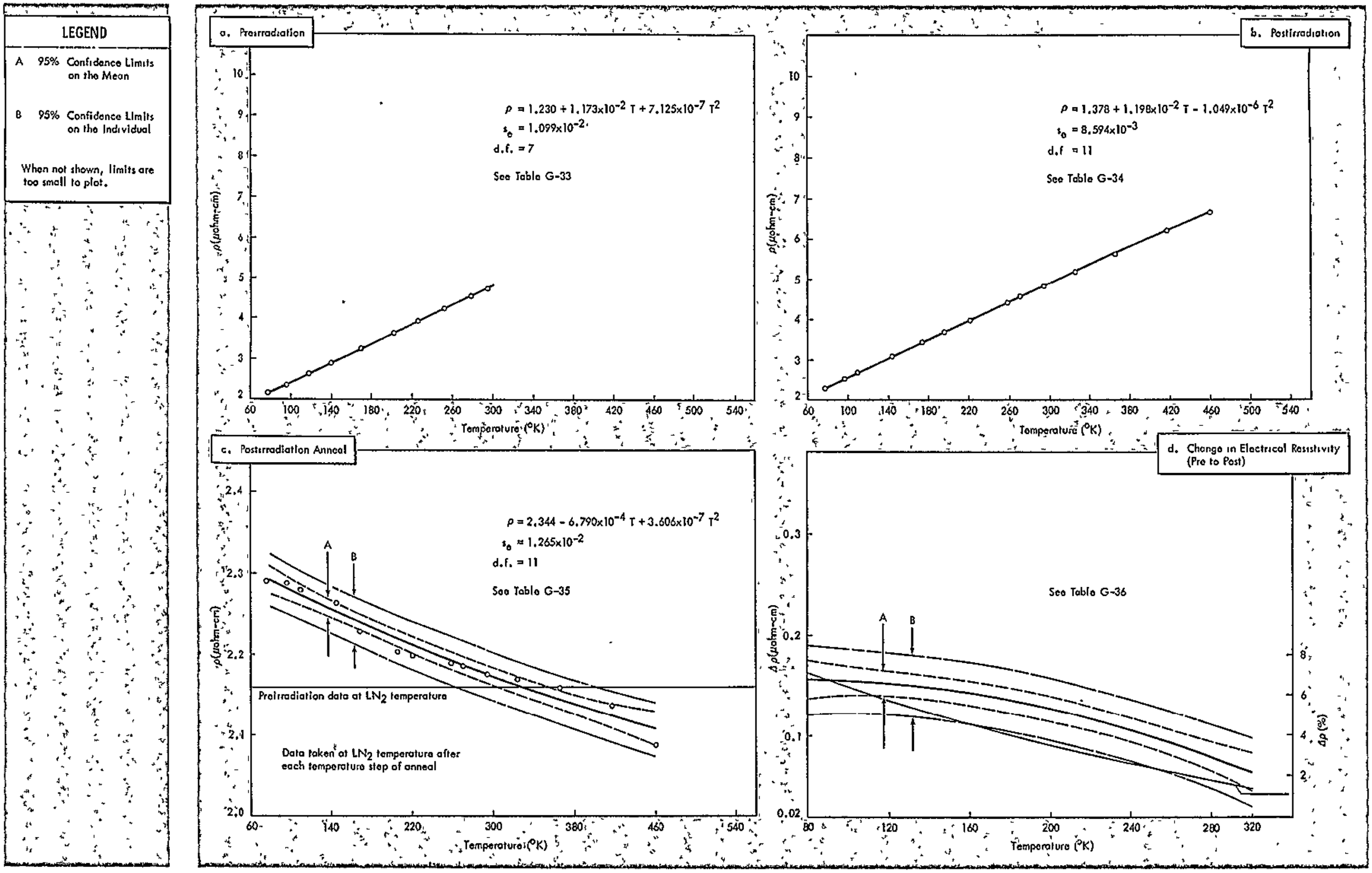

Figure 5-19 Electrical Resistivity of Aluminum 7039T61(2) as a Function of Temperature

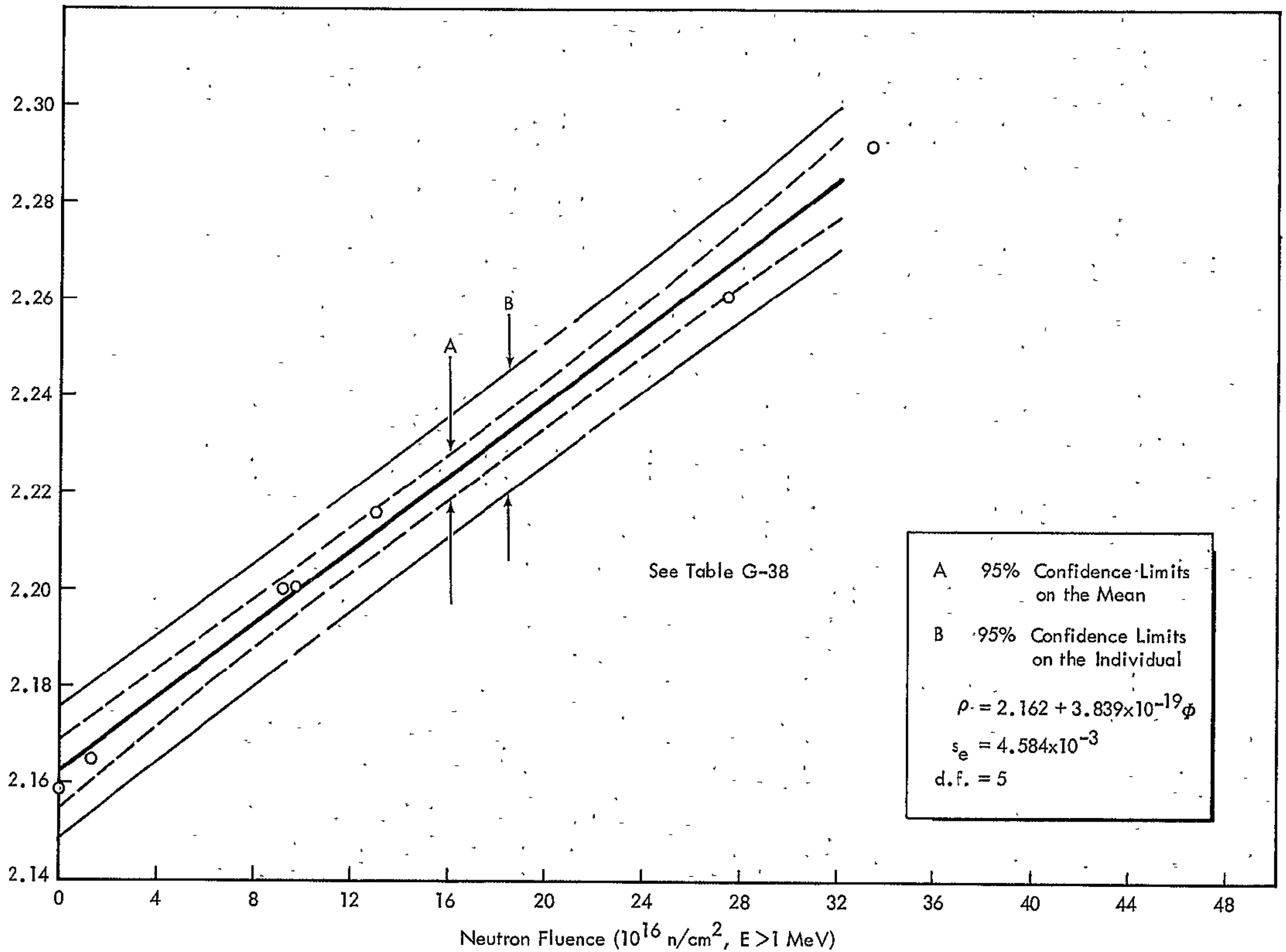

Figure 5-20 Electrical Resistivity of Aluminum 7039-T61(2) as a Function of Radiation Exposure at Zero Reactor Power

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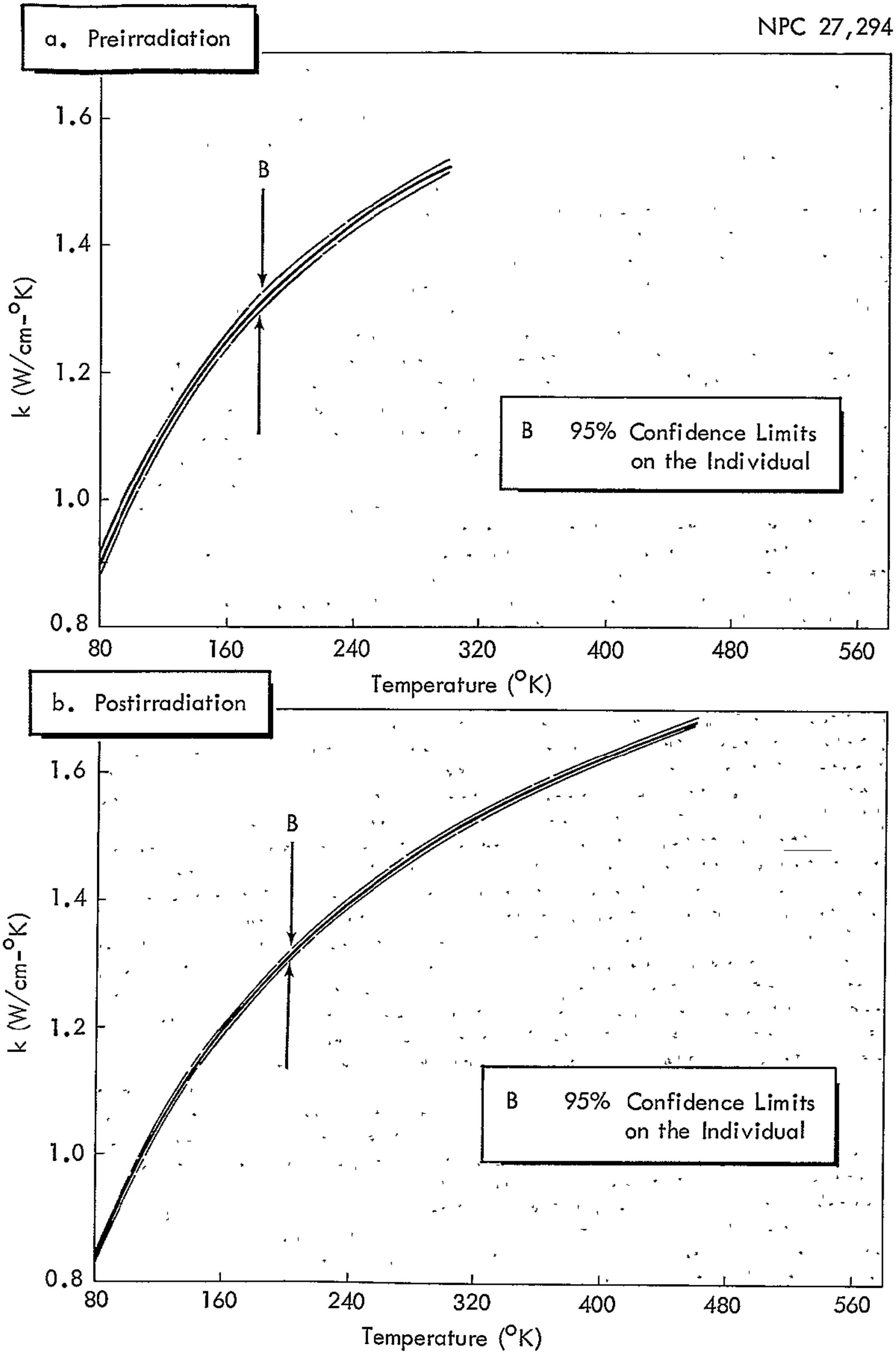

Figure 5-21 Calculated Thermal Conductivity of Aluminum 7039-T61(2) as a Function of Temperature

Table 5-8

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2) BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	118.5	140.5	169.5	202.0	226.0	252.5	278.5	295.0				
Avg Resistivity ($\mu\Omega$-cm)	2.159	2.355	2.620	2.884	3.243	3.629	3.931	4.242	4.558	4.743				
No. of Resistivity[a] Measurements	18	6	6	6	6	12	10	6	6	6				
Percent Standard Deviation	0.13	0.33	0.44	0.21	0.19	0.53	0.40	0.48	0.52	0.15				
Thermal Conductivity (watts/cm-°K)	0.878	0.999	1.108	1.194	1.281	1.364	1.409	1.458	1.497	1.524				
Postirradiation														
Avg Temperature (°K)	77.4	97.0	109.5	144.5	174.0	196.5	221.5	259.0	271.5	295.5	326.0	366.5	418.0	460.5
Avg Resistivity ($\mu\Omega$-cm)	2.291	2.535	2.686	3.095	3.428	3.683	3.973	4.407	4.556	4.826	5.174	5.634	6.218	6.660
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	8	6	6	6	6	4	4
Percent Standard Deviation	0.04	0.40	0.35	0.43	0.27	0.07	0.16	0.95	0.09	0.04	0.10	0.21	0.02	0.05
Thermal Conductivity (watts/cm-°K)	0.828	0.938	0.999	1.144	1.244	1.307	1.366	1.440	1.460	1.500	1.544	1.594	1.647	1.694
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	97.0	109.5	144.5	174.0	196.5	221.5	259.0	271.5	295.5	326.0	366.5	418.0	460.5
Avg Resistivity ($\mu\Omega$-cm)	2.291	2.288	2.280	2.263	2.229	2.204	2.198	2.189	2.186	2.177	2.170	2.158	2.137	2.087
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.04	0.13	0.09	0.04	0.06	0.07	0.04	0.07	0.10	0.04	0.07	0.09	0.12	0.15

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.8 A-286 Steel

The data for the A-286 specimen are presented in Figures 5-22, 5-23, and 5-24, Table 5-9, and Tables G-39 through G-43 of Appendix G.

Figure 5-22 presents the calculated pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 76.43 μohm-cm at $80^{o}K$ to 92.55 μohm-cm at $300^{o}K$. The postirradiation data range from 76.59 μohm-cm at $80^{o}K$ to 93.67 μohm-cm at $460^{o}K$. A change in electrical resistivity at LN_2 temperature of approximately +0.4% with an experimental uncertainty of $\pm$0.9% was observed.

The data in Table 5-9 and Figure 5-22(c) shows that the first data point obtained in LN_2 after irradiation is lower thar the preirradiation data and the data taken at the last zero reactor power data cycle before the end of the irradiation. It is also inconsistent with the LN_2 data point taken after the $99^{o}K$ temperature step, which indicates a shift in that data in LN_2, just after completion of the irradiation, due to an unknown bias.

The electrical resistivity as a function of neutron fluence (Fig. 5-23) is constant.

Figure 5-24 presents the thermal conductivity calculated using the pre- and postirradiation electrical resistivity data. Experimental thermal conductivity data (Ref. 15) are plotted in

Figure 5-24(a) for comparison.

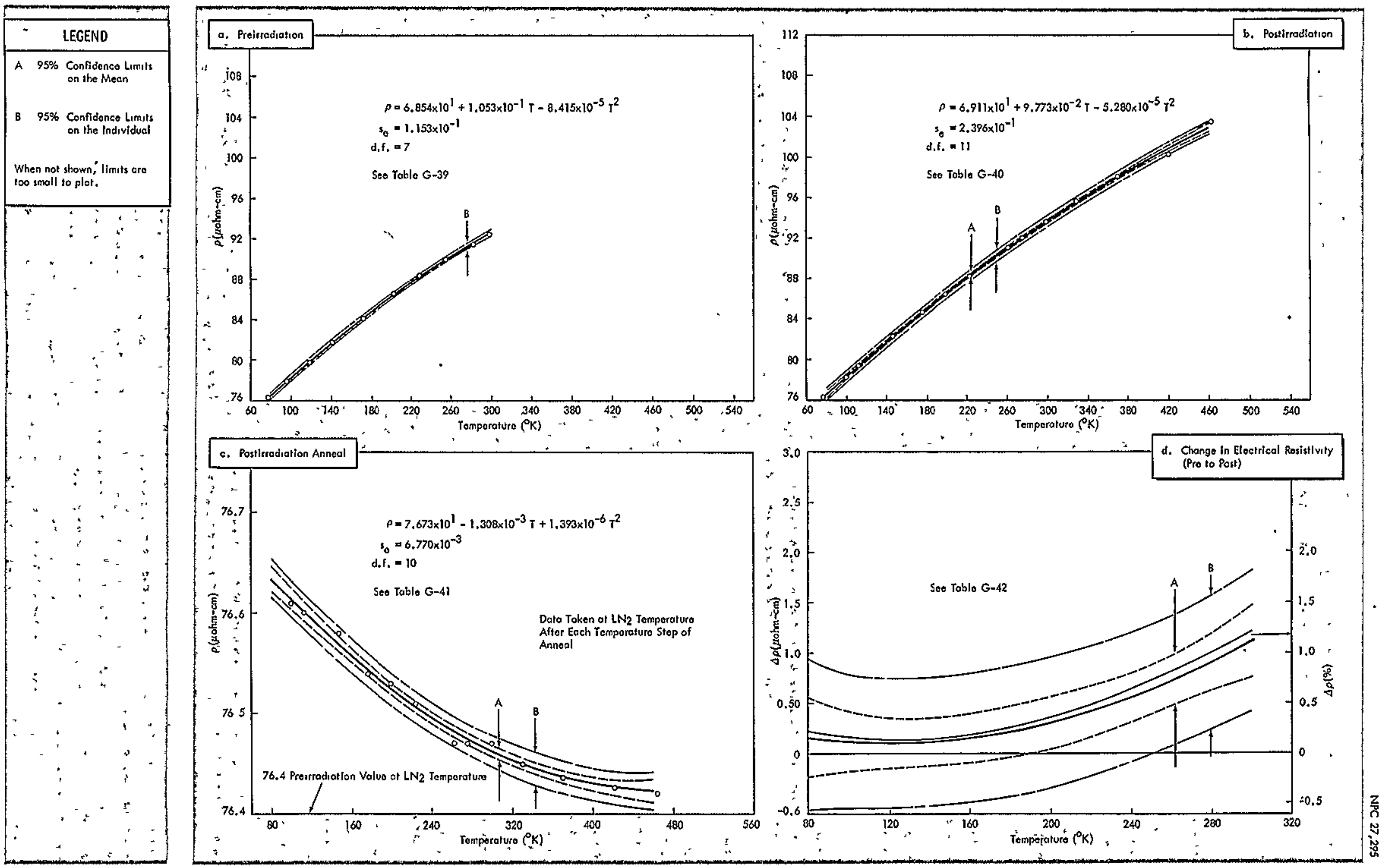

Figure 5-22 Electrical Resistivity of A-286 Steel as a Function of Temperature

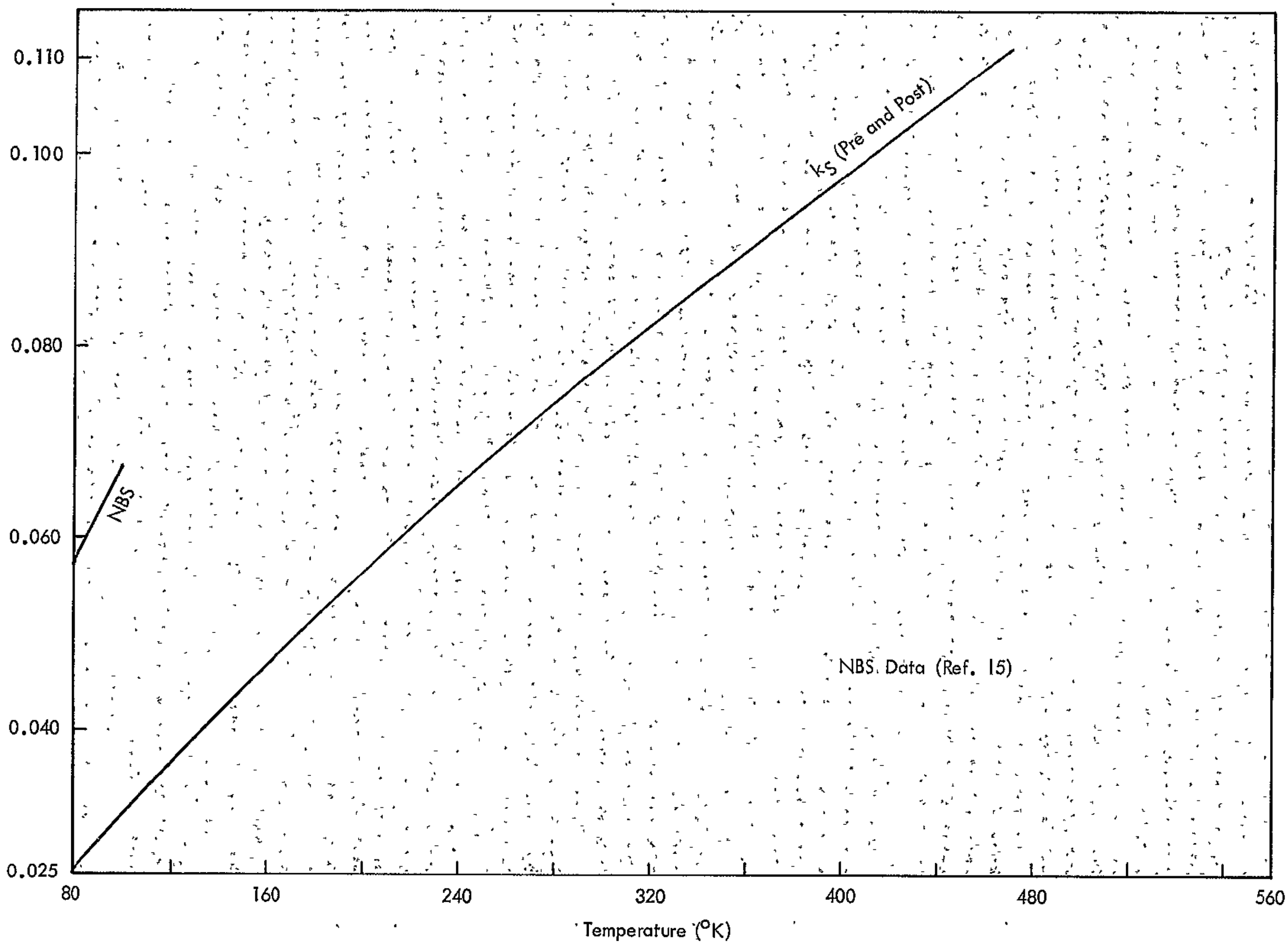

Figure 5-24 Calculated Thermal Conductivity of A-286 Steel as a Function of Temperature

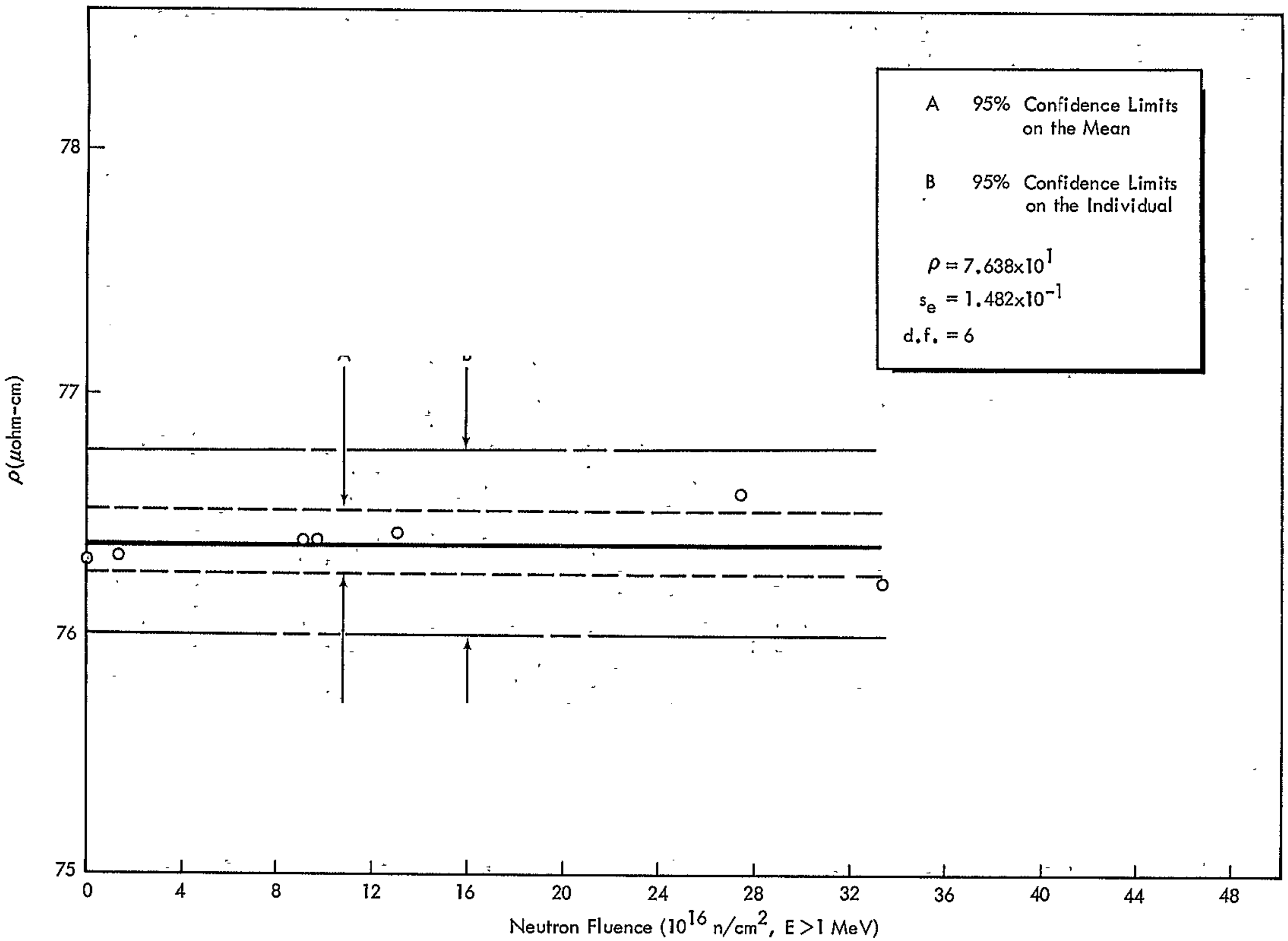

Figure 5-23 Electrical Resistivity of A-286 Steel as a Function of Radiation Exposure at Zero Reactor Power

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Table 5-9

ELECTRICAL RESISTIVITY OF A-286 BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	119.0	141.0	171.5	203.5	229.0	255.5	282.0	298.5				
Avg Resistivity ($\mu\Omega$-cm)	76.31	77.86	79.75	81.63	84.08	86.60	88.39	89.93	91.42	92.50				
No. of Resistivity[a] Measurements	18	6	6	6	6	12	4	6	6	6				
Percent Standard Deviation	0.02	0.12	0.12	0.06	0.05	0.12	0.27	0.19	0.07	0.04				
Thermal Conductivity (watts/cm-°K)	0.0247	0.0301	0.0364	0.0421	0.0498	0.0573	0.0632	0.0693	0.0753	0.0787				
Postirradiation														
Avg Temperature (°K)	77.4	99.0	111.5	145.5	175.5	199.0	223.5	262.0	275.0	299.0	330.0	370.5	421.5	464.5
Avg Resistivity ($\mu\Omega$-cm)	76.23	78.29	79.39	82.25	84.68	86.46	88.23	91.10	92.08	93.67	95.68	98.09	100.28	103.53
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	8	6	6	6	6	4	4
Percent Standard Deviation	0.07	0.06	0.07	0.11	0.07	0.05	0.09	0.26	0.09	0.04	0.03	0.15	0.18	0.05
Thermal Conductivity (watts/cm-°K)	0.0248	0.0309	0.0343	0.0432	0.0506	0.0562	0.0618	0.0702	0.0729	0.0779	0.0845	0.0925	0.1030	0.1092
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	99.0	111.5	145.5	175.5	199.0	223.5	262.0	275.0	299.0	330.0	370.5	421.5	464.5
Avg Resistivity ($\mu\Omega$-cm)	76.23	76.61	76.60	76.58	76.54	76.53	76.51	76.47	76.47	76.47	76.45	76.44	76.43	76.42
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.07	0.02	0.03	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.00	0.03

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.9 Stainless Steel 347

The data for stainless steel 347 are presented in Figures 5-25, 5-26, and 5-27, Table 5-10, and Tables G-44 through G-49 of Appendix G.

Figure 5-25 presents the calcualted pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 57.33 μohm-cm at 80°K to 77.97 μohm-cm at 300°K. The postirradiation data range from 57.66 μohm-cm at 80°K to 78.19 μohm-cm at 300°K to 90.13 μohm-cm at 460°K. A change in electrical resistivity at LN_2 temperature of approximately +0.7% with an experimental uncertainty of $\pm$0.9% was observed. The postirradiation-anneal data indicated that the specimen recovered completely after annealing at approximately 460°K.

In Figure 5-26, the electrical resistivity increased linearly at LN_2 temperature from 57.1 to 57.6 μohm-cm as a function of neutron fluence when exposed to 3.3×10^{17} n/cm^2 (E > 1 MeV).

Figure 5-27 presents the thermal conductivity calculated using the pre- and postirradiation electrical resistivity data. A comparison of experimental thermal conductivity data (Ref. 15) is made with the preirradiation data in Figure 5-27(a).

LEGEND

A 95% Confidence Limits on the Mean

B 95% Confidence Limits on the Individual

When not shown, limits are too small to plot.

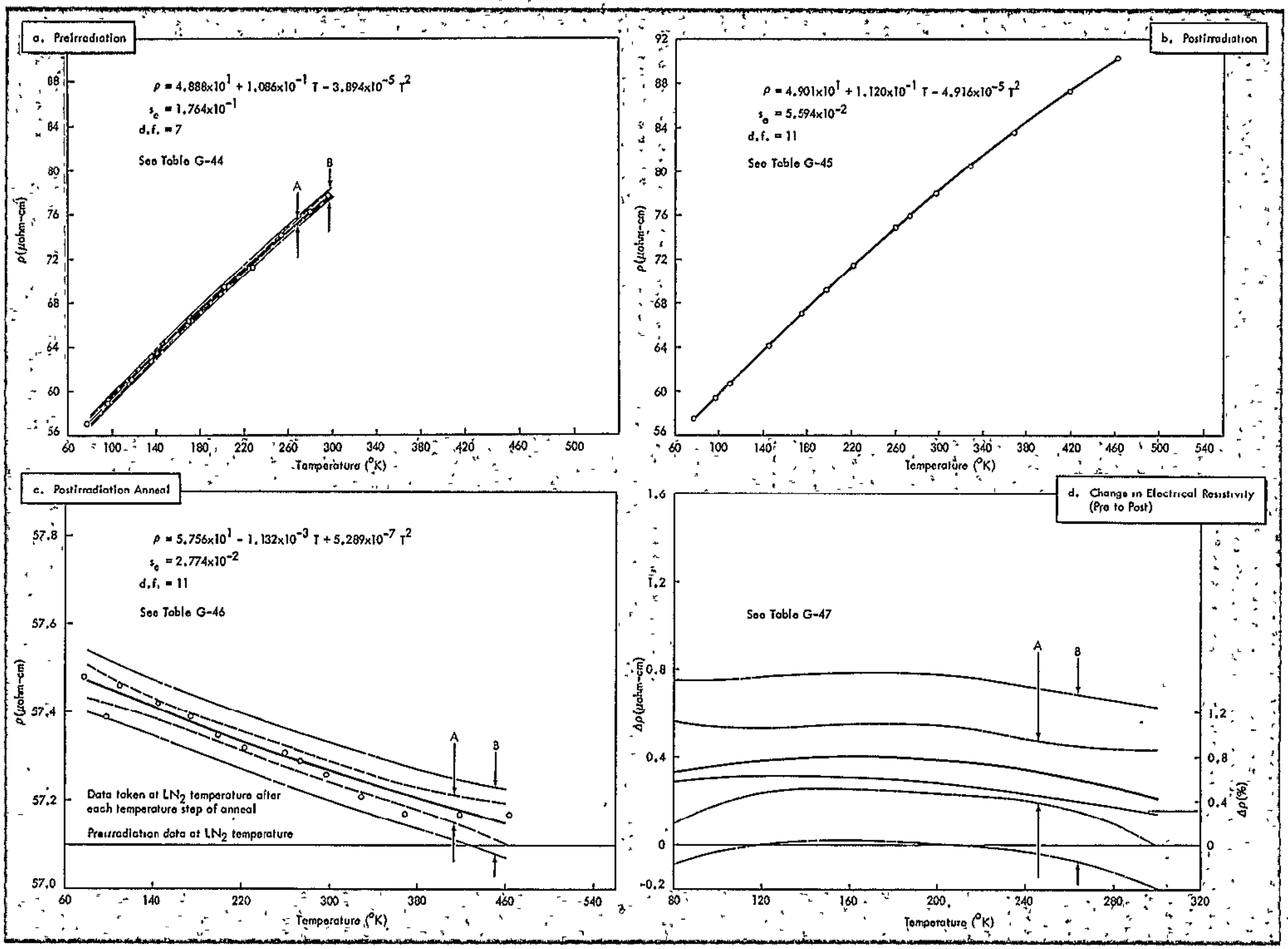

FIG. Figure 5-25 Electrical Resistivity of Stainless Steel 347 as a Function of Temperature

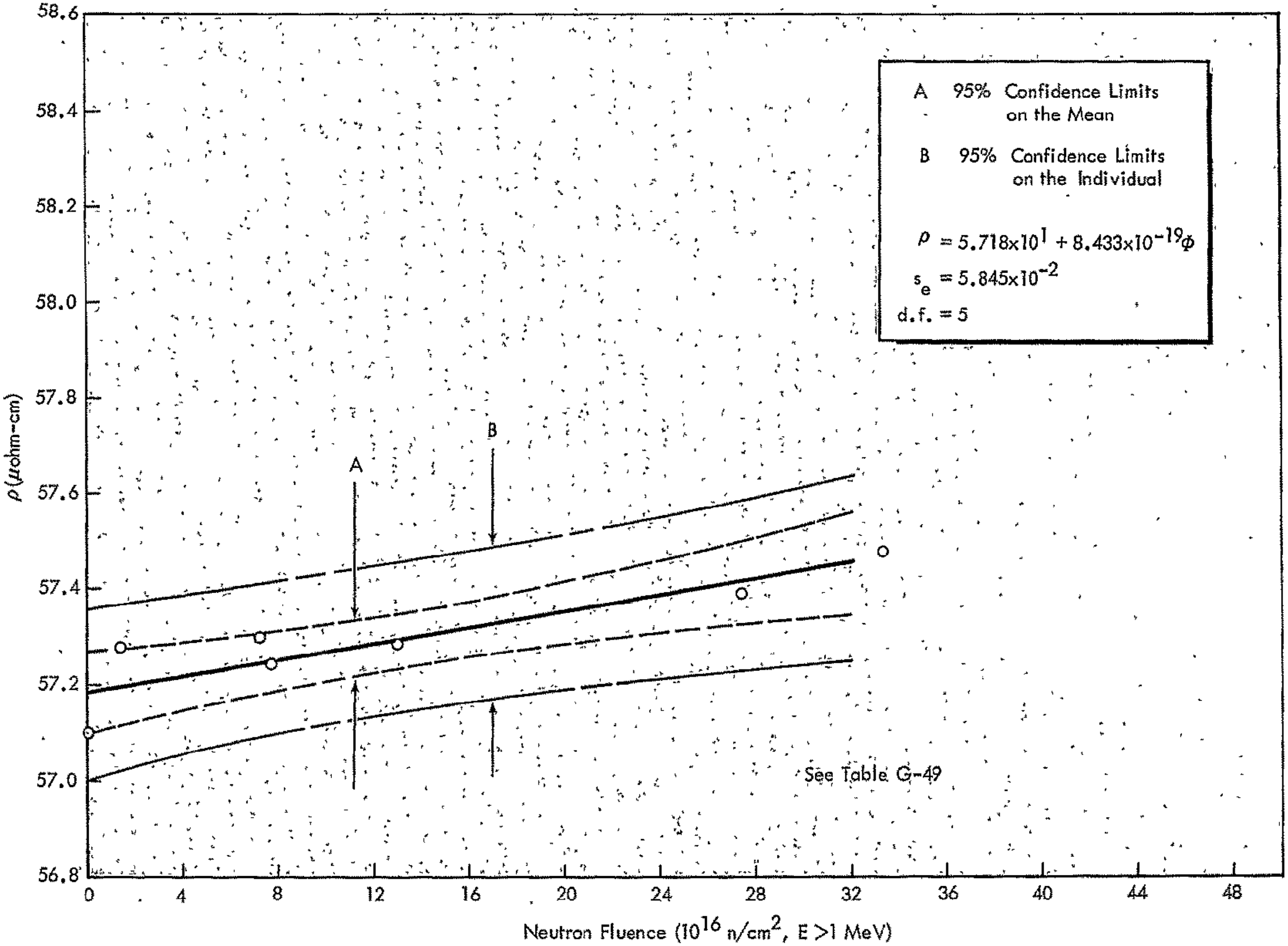

Figure 5-26 Electrical Resistivity of Stainless Steel 347 as a Function of Radiation Exposure at Zero Reactor Power

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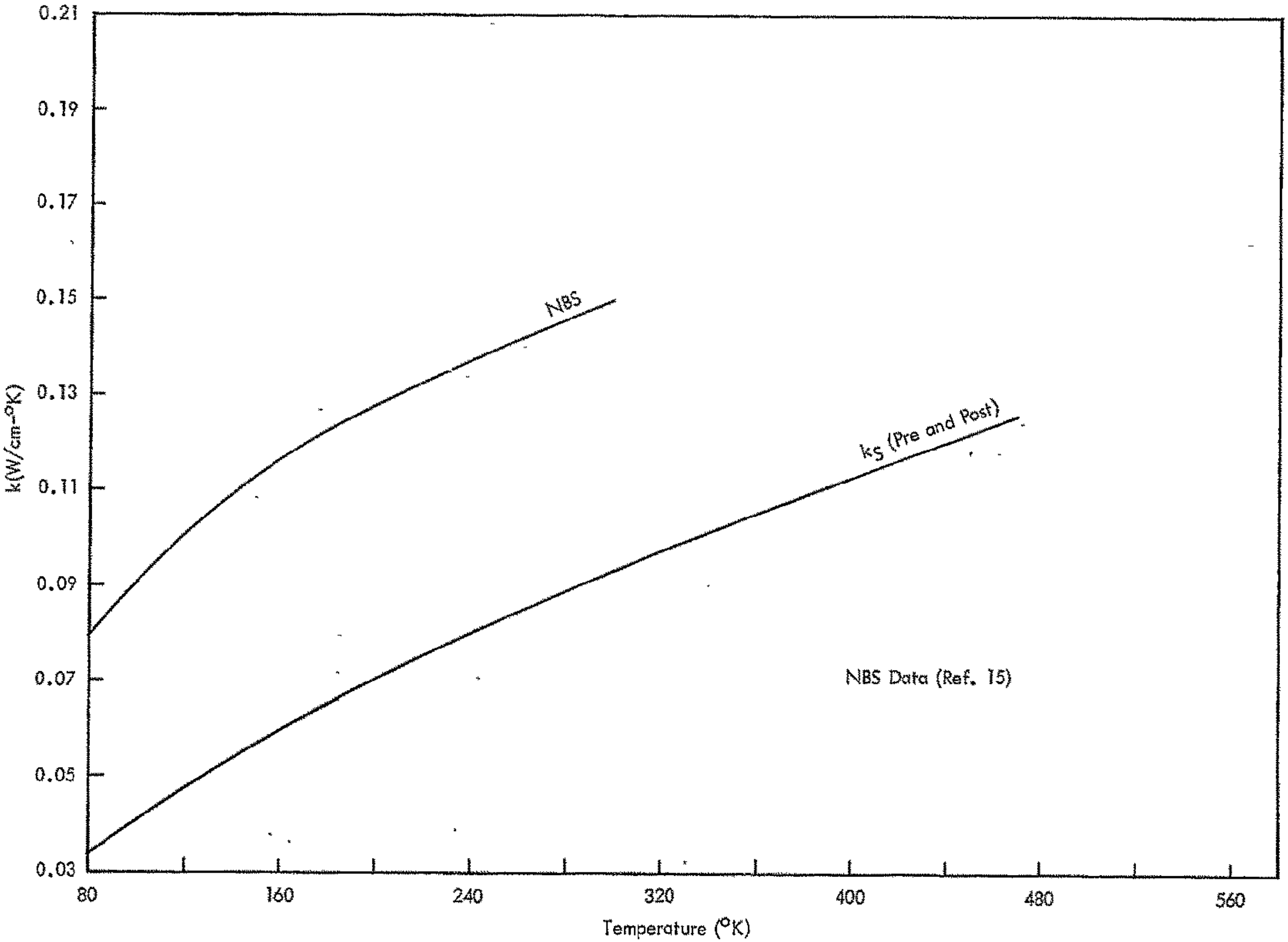

Figure 5-27 Calculated Thermal Conductivity of Stainless Steel 347 as a Function of Temperature

Table 5-10

ELECTRICAL RESISTIVITY OF SS-347 BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	118.5	141.0	170.5	202.5	228.0	254.0	280.5	297.0				
Avg Resistivity ($\mu\Omega$-cm)	57.10	58.89	61.16	63.44	66.40	69.45	71.25	74.11	76.26	77.75				
No. of Resistivity[a] Measurements	18	6	6	6	6	12	10	6	6	6				
Percent Standard Deviation	0.05	0.13	0.18	0.12	0.15	0.22	0.17	0.19	0.26	0.19				
Thermal Conductivity (watts/cm-°K)	0.0331	0.0398	0.0473	0.0542	0.0627	0.0711	0.0775	0.0836	0.0897	0.0932				
Postirradiation														
Avg Temperature (°K)	77.4	97.5	110.0	145.0	175.0	197.5	222.5	260.5	273.5	297.5	328.5	368.5	419.5	462.5
Avg Resistivity ($\mu\Omega$-cm)	57.48	59.41	60.69	64.17	67.07	69.26	71.51	74.94	75.98	77.99	80.44	83.56	87.33	90.32
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	8	6	6	6	6	4	4
Percent Standard Deviation	0.02	0.12	0.19	0.16	0.11	0.11	0.13	0.44	0.16	0.10	0.09	0.15	0.15	0.10
Thermal Conductivity (watts/cm-°K)	0.0329	0.0400	0.0442	0.0551	0.0637	0.0696	0.0759	0.0848	0.0878	0.0931	0.1001	0.1080	0.1177	0.1255
Postirradiation-Anneal[b]														
Avg Temperature (°K)	7 .4	97.5	110.0	145.0	175.0	197.5	222.5	260.5	273.5	297.5	328.5	368.5	419.5	462.5
Avg Resistivity ($\mu\Omega$-cm)	57.48	57.39	57.47	57.43	57.40	57.36	57.33	57.31	57.30	57.27	57.22	57.18	57.18	57.17
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	5	6	6	6	6	4	4
Percent Standard Deviation	0.02	0.55	0.04	0.01	0.02	0.02	0.04	0.01	0.02	0.01	0.01	0.02	0.00	0.03

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.4.10 Beryllium

The data for the beryllium specimen are presented in Figures 5-28, 5-29, and 5-30, Table 5-11, and Tables G-50 through G-55 of Appendix G.

Figure 5-28 presents the calculated pre- and postirradiation, and postirradiation-anneal electrical resistivity data, and the change in electrical resistivity as a function of temperature. The preirradiation data range from 1.600 μohm-cm at 80^{o}K to 3.312 μohm-cm at 220^{o}K. The postirradiation data range from 1.902 μohm-cm at 80^{o}K to 3.548 μohm-cm at 220^{o}K to 10.54 μohm-cm at 460^{o}K. A change in electrical resistivity at LN_2 temperature of approximately + 19.5% with an experimental uncertainty of $\pm$ 10.5% was observed. This change decreased to approximately + 6.0% at 230^{o}K. The postirradiation-anneal data in Figure 5-28(c) indicate complete recovery at approximately 260^{o}K.

The percent standard deviations for beryllium are slightly larger than those for the other specimens. This is primarily due to the low resistivity of beryllium. In addition, the beryllium specimen had voltage leads of different materials - one of nickel and one of copper. Essentially, this constituted a thermocouple in the emf circuitry, so that at most temperatures at which the data were obtained, the emf signal from the thermocouple effect was much higher than the true emf induced by applying current to the specimen. By measuring the thermocouple

emf of the circuit and then the combined emf of the thermocouple and the current, it was possible to determine the true emf induced by applying current to the specimen. Since this required taking the difference between two relatively large values, there was a resulting loss in precision.

The last three preirradiation data points for beryllium given in Table 5-11 are highly questionable since, contrary to information obtained from the literature (Ref. 16), they do not show an increase in electrical resistivity with increase in temperature. An attempt to repeat these measurements at the same temperature resulted in poor precision, as indicated by the relative standard deviations of 6.54% and 4.13% (Table 5-11). The most probable explanation is that there was moisture in either the emf or current wires. However, the problem seemed to resolve itself during the irradiation, as indicated by the postirradiation and postirradiation-anneal data.

The electrical resistivity at LN_2 temperature increased linearly as a function of neutron fluence (see Fig. 5-29) from 1.59 to 1.90 μohm-cm after an exposure of 3.3×10^{17} n/cm^2 ($E > 1$ MeV).

Figure 5-30 presents the thermal conductivity data calculated using the pre- and postirradiation electrical resistivity data. A change in thermal conductivity of these data is a constant and is compared with the 37/R104 test data in Figure 5-30(d).

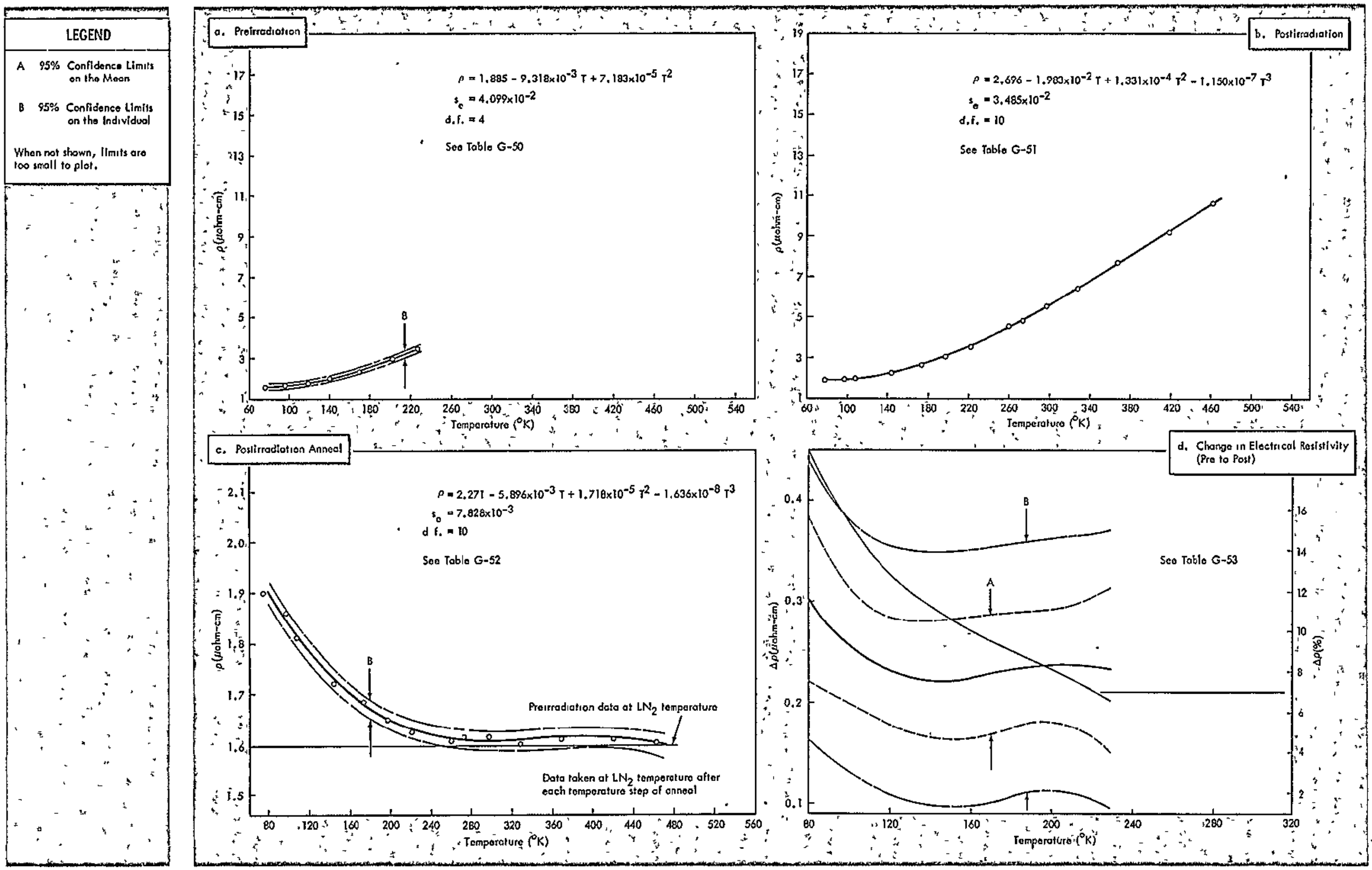

Figure 5-28 Electrical Resistivity of Beryllium as a Function of Temperature

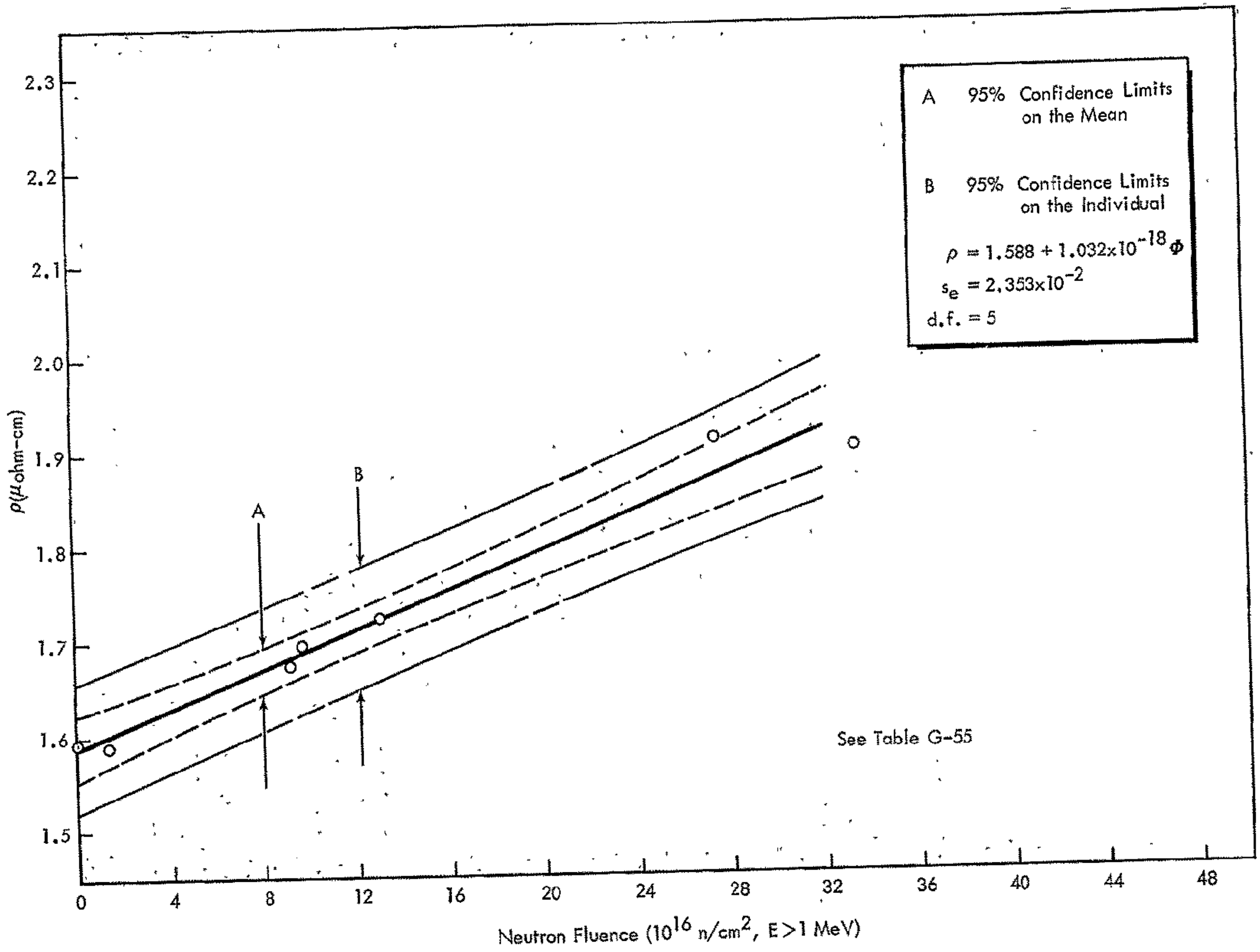

Figure 5-29 Electrical Resistivity of Beryllium as a Function of Radiation Exposure at Zero Reactor Power

NPC 27,302

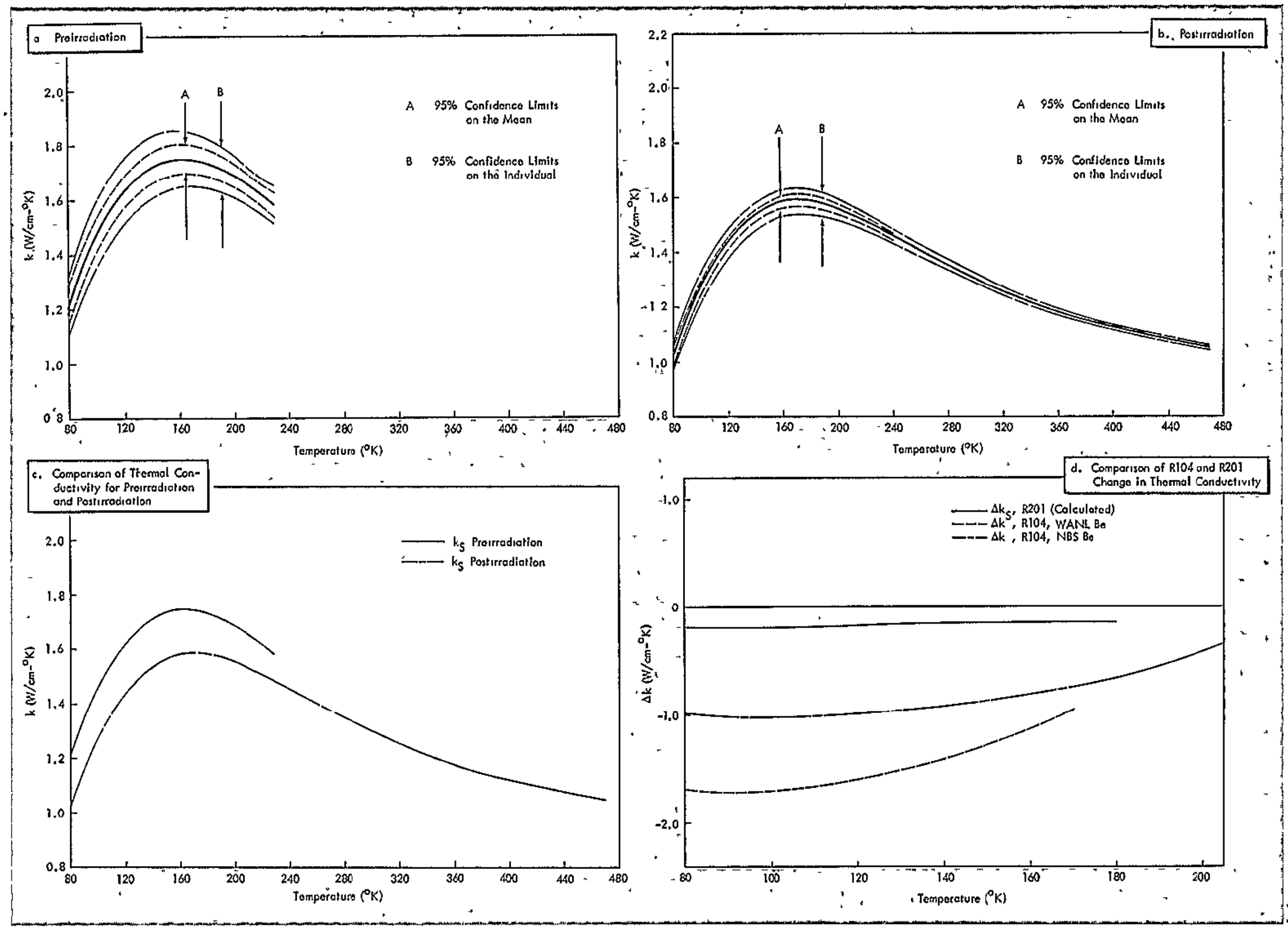

Figure 5-30 Measured and Calculated Thermal Conductivity of Beryllium as a Function of Temperature

Table 5-11

ELECTRICAL RESISTIVITY OF BERYLLIUM BEFORE AND AFTER IRRADIATION

Preirradiation														
Avg Temperature (°K)	77.4	96.0	119.0	140.5	170.0	202.0	227.0	254.0	279.5	305.0				
Avg Resistivity ($\mu\Omega$-cm)	1.594	1.658	1.788	2.008	2.330	2.994	3.446	3.196	2.994	3.268				
No. of Resistivity[a] Measurements	18	6	6	6	6	12	6	12	12	12				
Percent Standard Deviation	3.48	1.55	6.26	0.99	0.89	3.28	0.62	6.54	0.71	4.13				
Thermal Conductivity (watts/cm-°K)	1.189	1.419	1.631	1.714	1.788	1.653	1.614	1.947	2.287	2.287				
Postirradiation														
Avg Temperature (°K)	77.4	96.5	108.0	144.5	174.0	197.0	221.5	260.0	273.5	297.0	328.0	368.0	419.0	462.5
Avg Resistivity ($\mu\Omega$-cm)	1.901	1.927	1.962	2.249	2.678	3.079	3.561	4.533	4.826	5.554	6.467	7.726	9.215	10.642
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	8	6	6	6	6	4	4
Percent Standard Deviation	0.45	1.10	0.70	1.05	0.68	1.54	1.81	2.25	1.68	0.73	0.40	0.67	2.13	0.91
Thermal Conductivity (watts/cm-°K)	0.998	1.227	1.349	1.574	1.592	1.568	1.524	1.405	1.388	1.310	1.243	1.167	1.114	1.065
Postirradiation-Anneal[b]														
Avg Temperature (°K)	77.4	96.5	108.0	144.5	174.0	197.0	221.5	260.0	273.5	297.0	328.0	368.0	419.0	462.5
Avg Resistivity ($\mu\Omega$-cm)	1.901	1.863	1.811	1.721	1.685	1.649	1.624	1.607	1.613	1.615	1.605	1.614	1.609	1.603
No. of Resistivity[a] Measurements	8	6	6	6	6	6	6	6	6	6	6	6	4	4
Percent Standard Deviation	0.45	0.33	1.40	0.98	1.01	1.11	1.37	0.73	0.92	0.96	0.93	0.81	0.60	0.91

[a] Two resistivity measurements for each temperature measurement.

[b] Resistivity measured at LN_2 temperature.

5.5 Conclusions

Complete recovery from radiation effects was experienced in all specimens except graphite after annealing temperatures to 465°K. A 10% residual change was still observed in the graphite specimen.

The largest changes in electrical resistivity occurred in graphite, beryllium, and aluminum, respectively. This concurred with data from the 37/R104 test reported in Section III.

It had been concluded in Section III that the Wiedmann-Franz Law, when used with the Sommerfeld Value of the Lorenz ratio, could not be used to predict thermal conductivity from measured electrical resistivity with a very good accuracy. The conclusions from this experiment concur with the conclusions in Section III.

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APPENDIX A

GTR RADIATION EFFECTS TESTING SYSTEM

The GTR Radiation Effects Testing Facility is located in the Reactor Operations Area at the north end of the NARF complex. Figure A-1 is a plan view and Figure A-2 is a cutaway view of the facility. A top view of the irradiation test cell and the reactor tank is pictured in Figure A-3. During operation, the reactor is moved into the closet-like structure built into the north wall of the GTR tank. Items to be irradiated can be located on the north, east, or west sides of the closet, as indicated in the figures.

The reactor closet is constructed of 1-in. aluminum plate and is partially covered by 1/4-in.-thick boral to attenuate thermal neutrons. The boral extends 36 in. east and west from the closet along the tank wall and 36 in. up and down from the horizontal centerline of the reactor core.* The centerline is 57 in. above the test-cell floor.

The Ground Test Reactor (GTR) is a heterogeneous, highly enriched, thermal reactor that utilizes water as neutron moderator and reflector, as radiation shielding, and as coolant. Maximum power generation is 10 MW. The GTR, in an aluminum enclosure to facilitate cooling-water flow, is suspended by

*The boral was removed for this experiment (see Appendix B).

an open framework that is carried on a horizontal positioning mechanism at the top of the reactor tank. This mechanism permits the reactor to be positioned at distances ranging from 2 to 87 in. from the north face of the closet.

Adjacent to the north wall of the irradiation cell is the handling area. In this area, various connections are made for cryogenic, hydraulic, and pneumatic equipment.

An integral part of the GTR testing facility is the shuttle system, which is used to move test assemblies to and from the irradiation positions. This system consists of cable-driven dollies mounted on three sets of parallel tracks. The tracks extend from the irradiation positions adjacent to the reactor closet, up an incline to the north wall of the irradiation cell, and to a loading area on the ramp just north of the handling area. The system can be operated from either the control room or the dolly motor-drive shed on the north ramp. Full-coverage televiewing of the entire shuttle system is provided by means of a closed-circuit television in the control room. Test assemblies that cannot be accommodated by the shuttle system are lowered into position by a crane.

The control room (Fig. A-1) is a below-grade, reinforced concrete structure adjacent to the GTR system. The control room provides a shielded area for reactor instrumentation,

control consoles, and test systems, as well as special test equipment needed to conduct radiation experiments.

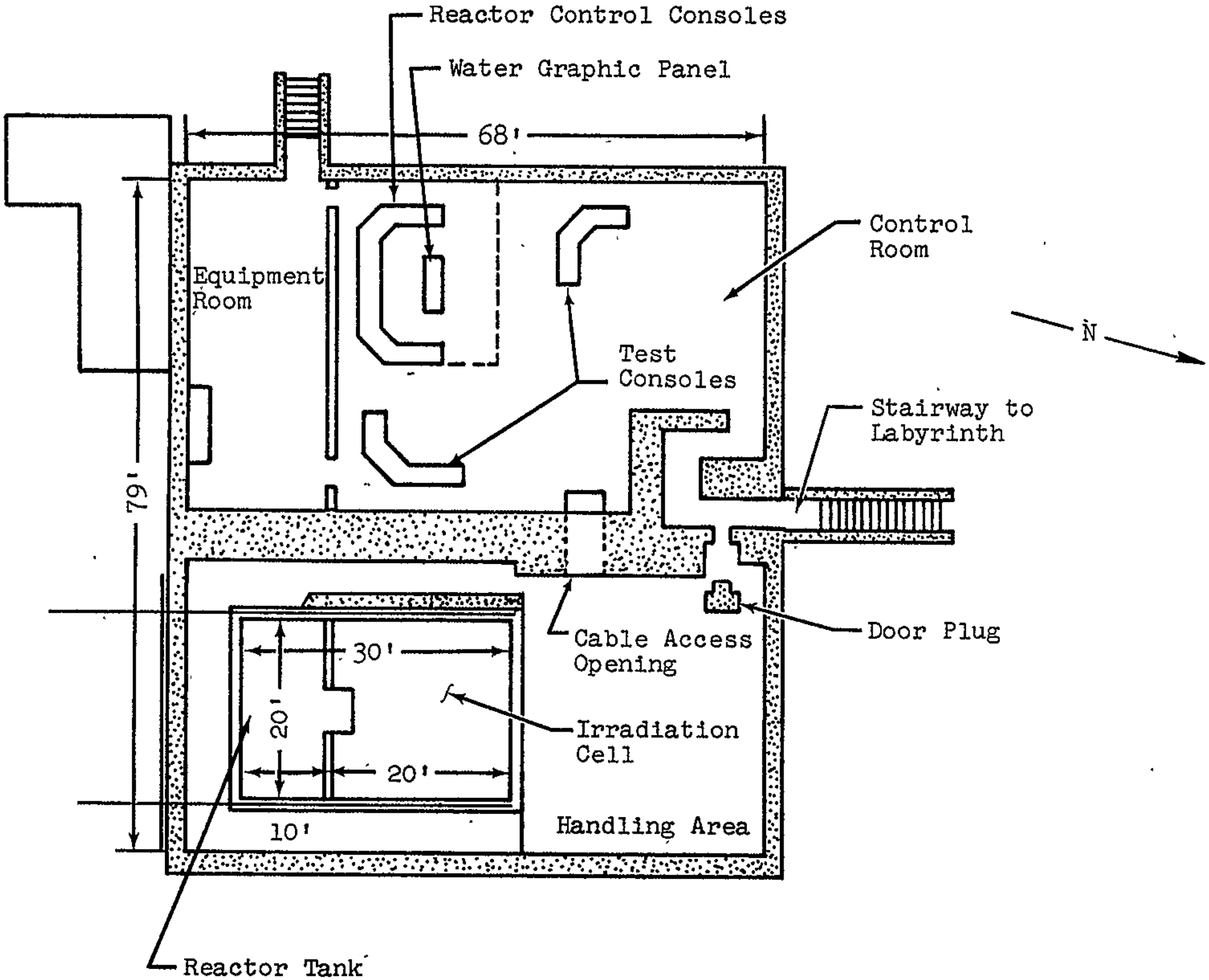


Figure A-1 GTR Radiation Effects Testing Facility

NPC 26,668

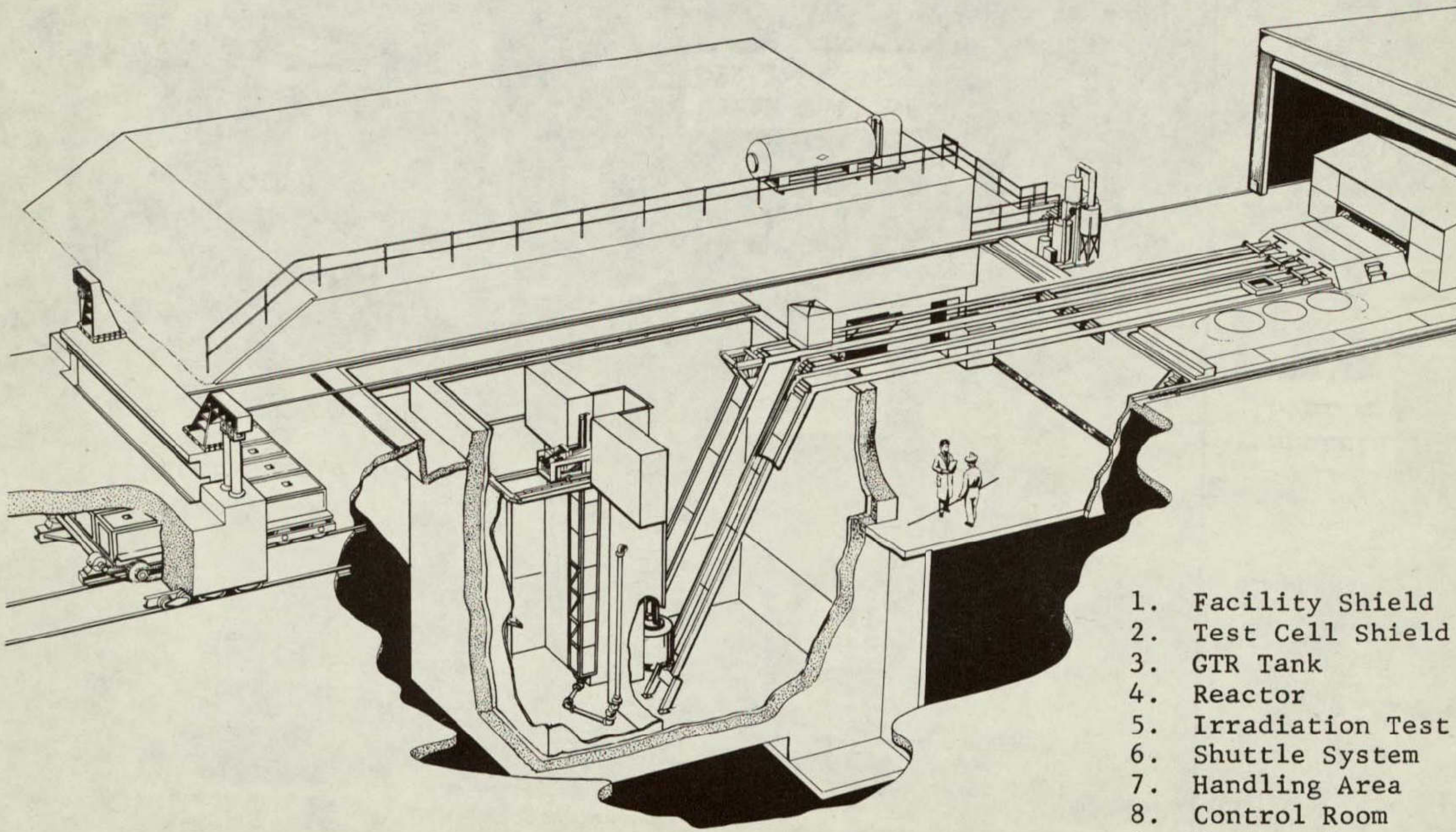
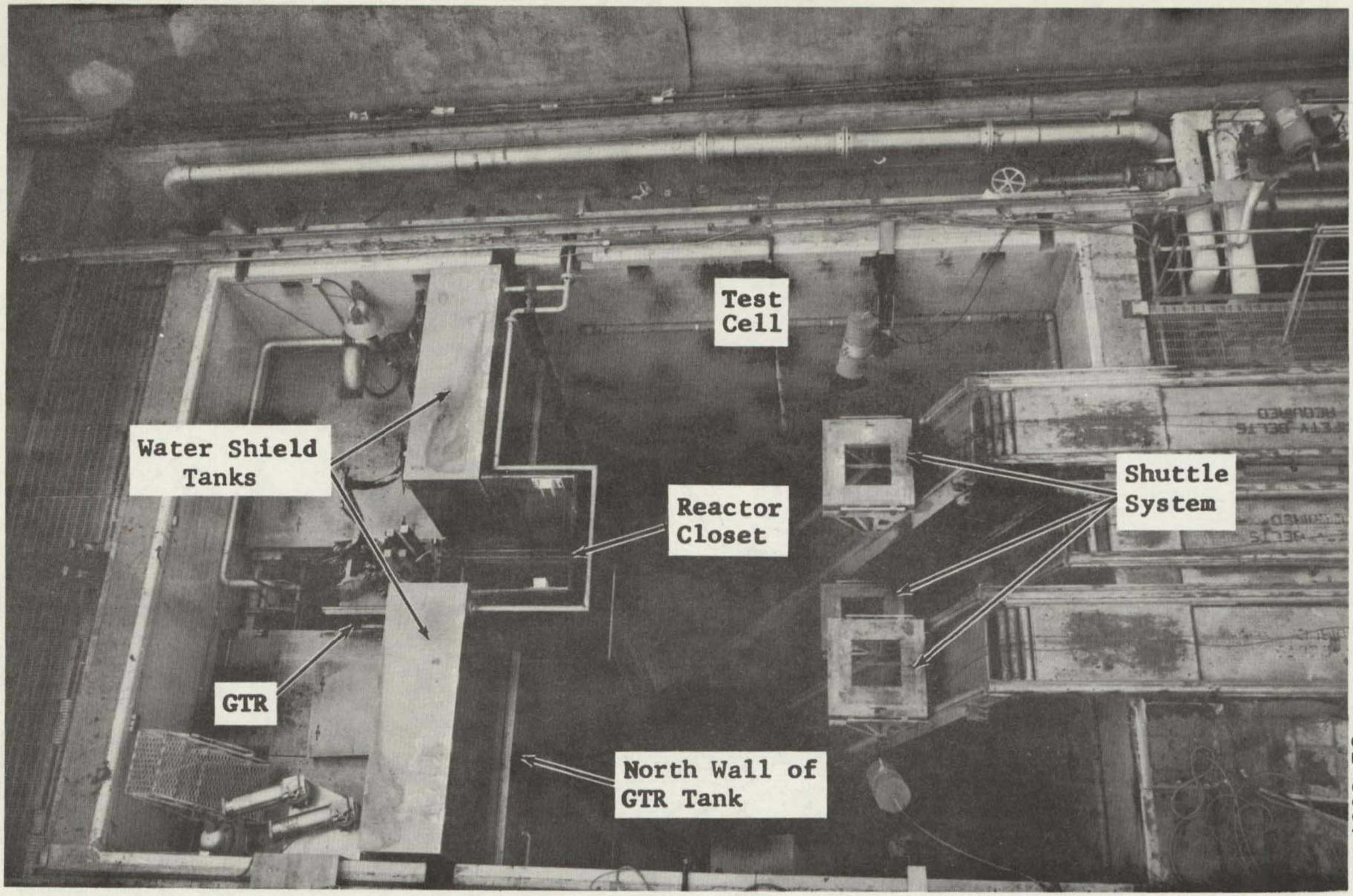


Figure A-2 GTR Tank and Irradiation Test Cell - Cutaway View



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31-8887

Figure A-3 GTR Tank and Irradiation Test Cell - Top View

APPENDIX B

DOSIMETRY TECHNIQUES AND DATA

B-1 Nuclear Measurements

Nuclear measurements were determined from dosimetry packets attached near the test components. Each packet consisted of a 3- by 3.5-in. aluminum plate with the following detectors attached:

- One sulfur pellet for measuring fast-neutron fluence ($E > 2.9$ MeV)
- Two phosphorus pellets (one bare, one cadmium-covered) for measuring thermal-neutron fluence ($E < 0.48$ eV).

B-1.1 Neutron Fluence

The phosphorus and sulfur pellets used in this experiment were compressed with a hydraulic press from compounds of aluminum metaphosphate and calcium sulfate, respectively. These pellets were developed for high-flux and high-temperature irradiations and have proved to be strong, hard, and chip-resistant. A detailed description of these pellets is given in Reference 17.

The ratio of neutron flux for $E > 1$ MeV to that for $E > 2.9$ MeV has been established to be 2.8 (Ref. 18). This ratio was used to obtain values of the neutron fluence for $E > 1.0$ MeV from the sulfur data. Standard foil techniques were used in specifying the neutron field (Ref. 18). All

foils were counted in the NARF Nuclear Measurements Laboratory and the data fed into an IBM 7090 digital computer program for computation of the neutron fluence.

The accuracy of the fast-neutron-fluence values is primarily dependent on the accuracy with which the target-isotope cross section is known. For the $S^{32}(n,p)P^{32}$ reaction, the cross section is 300 ± 30 millibarns. The extrapolation from the measured sulfur fluence ($E > 2.9$ MeV) to the neutron fluence for $E > 1$ MeV requires that the shape of the neutron spectrum be known. The uncertainty in the spectrum introduces a ±10% uncertainty in the fluence above 1 MeV (Ref. 15). Since it is also necessary to extrapolate from a dosimetry location to a test-specimen location, an additional uncertainty of ±10% is introduced. The uncertainty due to the counter calibration and the counting statistics is no more than 5%. The estimated accuracy of the fluence above an energy of 1 MeV is, therefore, ±15%.

The thermal-neutron fluences are estimated to be accurate to within ±12%. The cross section for the $P^{31}(n,\gamma)P^{32}$ reaction is 190 ± 9.5 millibarns. The uncertainty in making the extrapolation from the detector location to the test-specimen location is estimated to be ±10%. The counter calibration and counting statistics introduce an uncertainty of about ±5%.

B-1.2 Gamma Dose

The gamma doses to which the specimens were exposed exceeded the dose for which routine gamma detectors such as N_2O dosimeters are considered reliable. The reported gamma doses were determined by applying previously measured neutron-to-gamma ratios for similar experimental configurations to the neutron fluences measured during this experiment.

It is estimated that the gamma doses are accurate to $\pm 21\%$, based on a $\pm 15\%$ uncertainty in using the previously measured neutron-to-gamma ratios.

B-2 Dosimetry Results

B-2.1 Thermal Conductivity/Electrical Resistivity Test

Dosimetry packets were attached to the test apparatus at the locations indicated in Figure B-1. This figure also shows, for each packet location, the measured thermal-neutron fluence; the neutron fluence for $E > 1$ MeV, taken as 2.8 times the fluence measured with the sulfur detectors; and the gamma dose computed from the measured fast-neutron fluence and neutron-to-gamma ratios. Also given are the estimated neutron fluences ($E > 1.0$ MeV) to which each specimen was exposed. The extrapolation from detector locations

to the specimen locations was in part based on mapping data obtained in earlier experiments.

B-2.2 Electrical Resistivity Test

Four dosimetry packets attached around the outside of the electrical resistivity apparatus were used to measure the neutron exposure of the specimens. An average of the four measurements gives fluences of

$$3.33 \times 10^{17}\ n/cm^2,\ E > 1.0\ MeV$$

$$1.25 \times 10^{16}\ n/cm^2,\ E < 0.48\ eV$$

The estimated gamma dose is 3.2×10^{11} ergs/g(C).

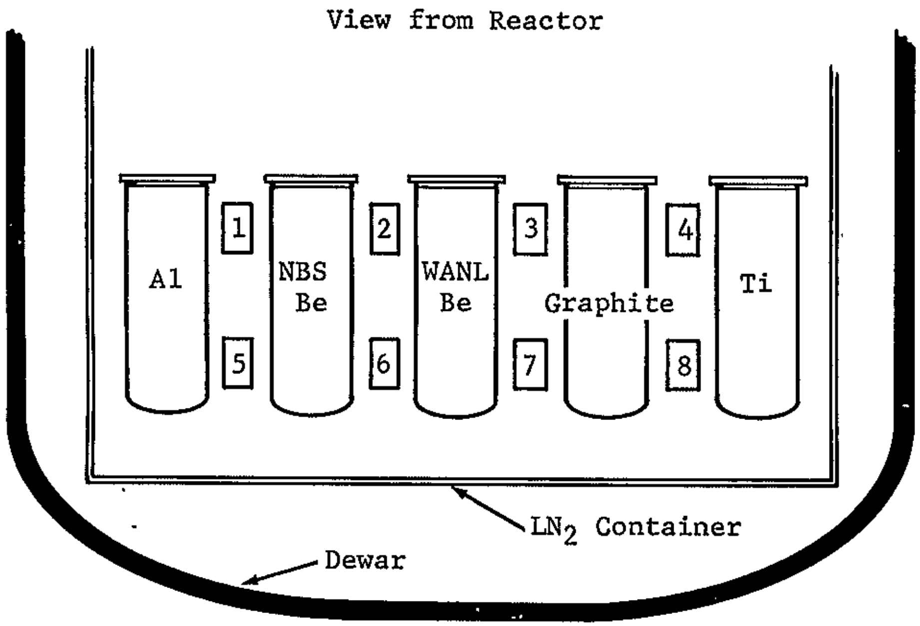
B-3 Analytical GTR Neutron Spectrum

The neutron spectrum (Ref. 17) of the GTR in a water moderator has been measured to be Maxwellian at thermal energies ($E < 0.48$ eV), approximately E^{-1} from about 0.5 ev to 0.1 MeV, and essentially a fission spectrum for higher energies. In Figure B-2, this spectral shape has been mathematically altered to account for the attenuation of thermal flux by the boral surrounding the reactor in the dry-pool configuration on the east and west sides. The resulting spectrum has been shown to represent the actual spectrum fairly accurately.

Flux measurements have been made in the thermal-, epithermal-, and fast-neutron energy ranges by use of a

variety of thermal, resonance, and threshold detectors. Fast-neutron flux measurements ($E > 2.9$ MeV) made on the dry side with the boral in place agree with those made on the wet (tank) side. The measured thermal fluxes on the east and west sides are in general agreement with that obtained by integration of the analytical curve shown in Figure B-2.

For this experiment the boral thermal-neutron shield on the north reactor face was replaced with a 1/8-in. sheet of aluminum that had been plasma-sprayed with equal parts by weight of 92% enriched boron-10 and Al_2O_3 powder. The new configuration resulted in a higher thermal-neutron leakage than in past experiments, as is indicated by the integrated thermal-neutron data given in Figure B-1



Average Neutron Fluence per Specimen (n/cm^2, E > 1 MeV)				
Al	NBS Be	WANL Be	Graphite	Ti
0.50(18)	1.1(18)	1.3(18)	1.1(18)	0.50(18)

Neutron Fluence and Gamma Dose at Dosimetry Locations

Radiation Exposure	Dosimetry Location							
	1	2	3	4	5	6	7	8
Neutron Fluence (n/cm^2)								
E < 0.48 eV	1.84(17)	3.32(17)	3.28(17)	2.21(17)	1.35(17)	3.33(17)	3.31(17)	2.12(17)
E > 1.00 MeV	0.64(18)	1.02(18)	1.00(18)	0.64(18)	0.83(18)	1.33(18)	1.17(18)	0.81(18)
Gamma Dose [ergs/g(C)]	0.52(12)	0.98(12)	0.96(12)	0.46(12)	0.64(12)	1.28(12)	1.12(12)	0.57(12)

Figure B-1 Dosimetry Locations and Readout for Thermal Conductivity Test

NPC 26,666

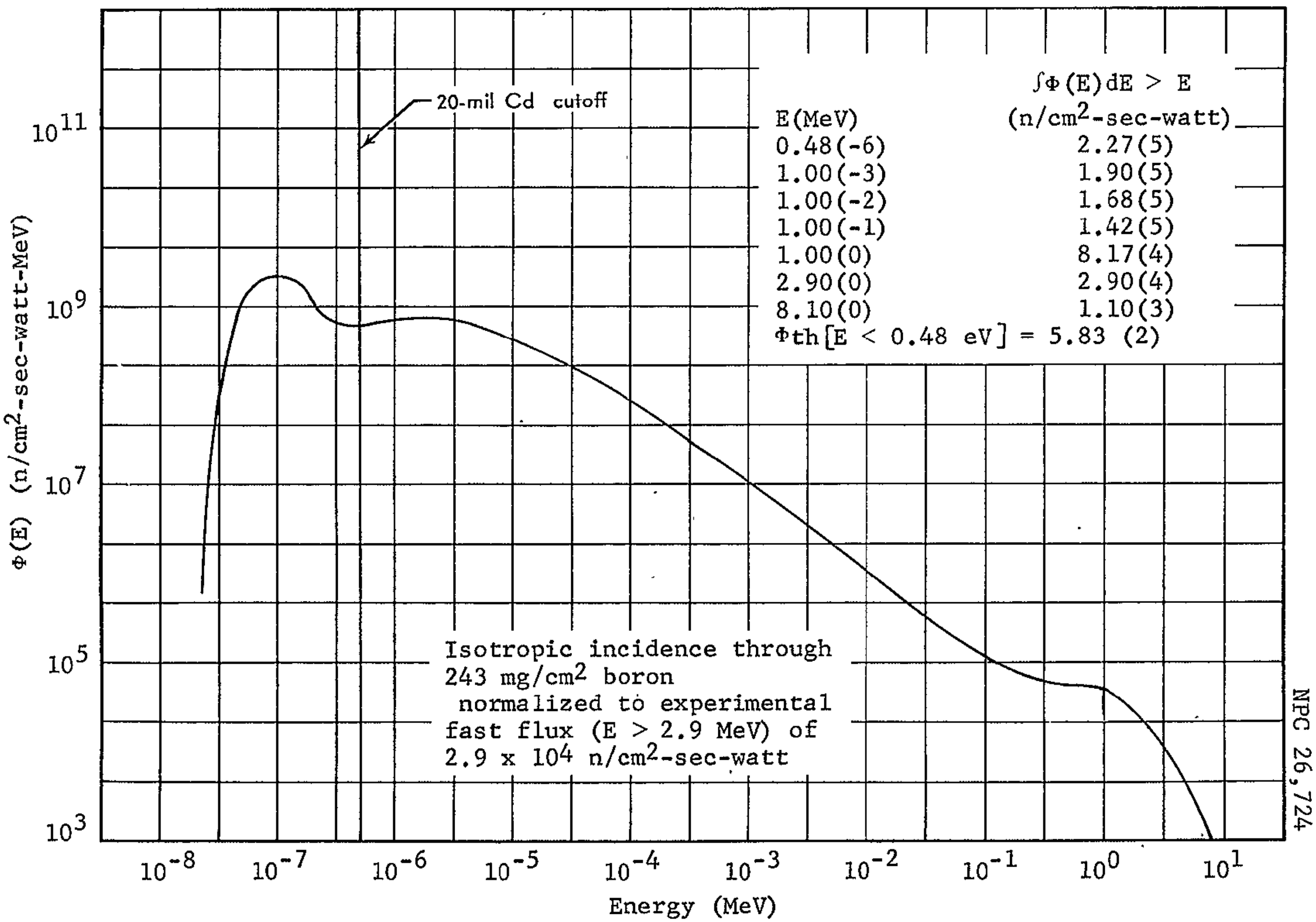


Figure B-2 Analytical GTR Neutron Spectrum

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APPENDIX C

REACTOR LOG

Date (1967)	Time	Power Level (MW)	Elapsed Time (min)	Accumulated Exposure (MW-h)
Oct 13				
	1741	6.00	2	0.20
	1743	6.95	73	8.66
	1856	5.00	64	13.99
	2000	4.90	600	62.99
Oct 14				
	0600	4.80	221	80.67
	0941	0.93	38	81.26
	1019	6.30	8	82.10
	1027	0.00	32	82.10
	1059	4.80	481	120.58
	1900	4.70	666	172.75
Oct 15				
	0606	4.60	791	233.39
	1917	2.30	82	263.53
	2039	4.60	1020	314.73
Oct 16				
	1339	7.06	146	331.91
	1605	7.20	1291	486.83
Oct 17				
	1336	4.00	5	487.17
	1341	0.72	10	487.30
	1351	7.20	457	542.14
	2128	4.00	5	542.47
	2133	7.20	806	639.19
Oct 18				
	1059	0.00	45	639.19
	1144	0.50	9	639.27
	1153	5.00	419	674.14
	1852	0.00	1491	674.14

APPENDIX C (Cont'd)

Date (1967)	Time	Power Level (MW)	Elapsed Time (min)	Accumulated Exposure (MW-h)
Oct 19				
	1943	7.20	181	695.86
	2244	0.00	22	695.86
	2306	7.20	144	713.14
Oct 20				
	0130	6.70	438	762.03
	0848	0.00	30	762.09
	0918	6.80	166	780.87
	1204	0.00	20	780.87
	1224	0.75	10	780.99
	1234	0.00	34	780.99
	1308	6.80	17	782.92
	1325	0.00	29	782.92
	1354	6.80	56	789.27
	1450	0.70	55	789.91
	1545	6.60	105	801.46
	1730	6.80	330	838.86
	2300	7.00	546	902.56
Oct 21				
	0806	0.00	1254	902.56
Oct 22				
	0500	7.20	240	931.36
	0900	6.80	30	934.76
	0930	6.70	30	938.11
	1000	6.60	90	948.02
	1130	6.50	9	948.99
	1139	0.00	28	948.99
	1207	6.50	653	1019.73
	2300	7.20	75	1028.73
Oct 23				
	0015	7.00	276	1060.93
	0451	6.70	119	1074.21
	0650	3.20	25	1075.55
	0715	6.70	225	1100.67
	1100	6.40	4452	1575.55
Oct 26				
	1312	6.20	1002	1679.09

APPENDIX C (Cont'd)

Date (1967)	Time	Power Level (MW)	Elapsed Time (min)	Accumulated Exposure (MW-h)
Oct 27				
	0554	6.40	258	1706.61
	1012	0.00	73	1706.61
	1125	6.40	1835	1902.35
Oct 28	1800	0.00	3732	1902.35
Oct 31				
	0812	0.04	11	1902.35
	0823	0.00	17	1902.35
	0840	5.00	4432	2271.68
Nov 3				
	1032	1.70	5	2271.83
	1037	0.00	9	2271.83
	1046	5.00	475	2311.41
	1841	Shutdown		

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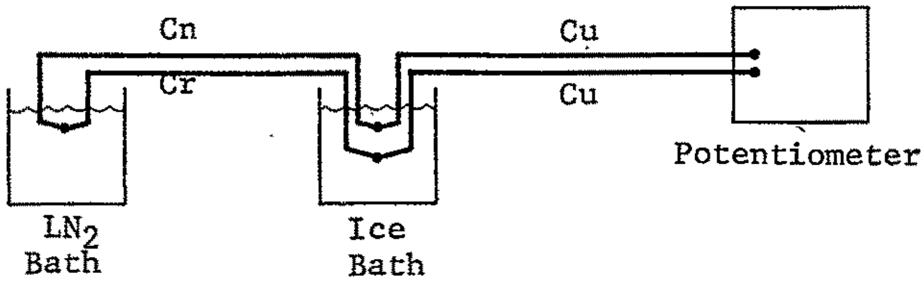
APPENDIX D

THERMOCOUPLE CALIBRATION

The Cryogenic Data Center of the National Bureau of Standards at Boulder, Colorado, maintains "standard" tables of voltage vs temperature for ten thermocouple pairs frequently used at low temperature (Ref. 20). Because it is unlikely that any one thermocouple will generate voltages identical to any other, it is necessary to adjust the values listed in the "standard" table before using them for a particular thermocouple. To make the required adjustment, a "spot" calibration of the thermocouple(s) to be used is made. This calibration consists of establishing the voltage for a definite temperature difference. This information is then fed into the NBS FACTOR computer program, which calculates the new voltage-vs-temperature values. Details of the calibration procedure performed at GDFWD are given below.

D-1 Method

Samples from two spools of thermocouple wire, one of constantan and one of Chromel, were calibrated. Thermocouples were made from lengths of wire taken from the front, middle, and end sections of each spool of wire; the thermocouple beads were made by melting the tips of the wires together. A typical calibration setup is shown below.



Two calibrations were made - one using liquid nitrogen (LN_2) and an ice bath and one using liquid argon (LA) and an ice bath. The data shown in this appendix are for the LN_2 and ice bath only. A tertiary standard potentiometer was used to measure the output of the thermocouples. The barometric pressure was recorded before each measurement so that an accurate temperature of the LN_2 and LA baths could be determined. Corrections were also made for the depth of the thermocouples in the LA bath. A copper block was used as a temperature stabilizer for the thermocouples in the LN_2 and LA baths; the wires were rolled into spools approximately 6 to 8 in. from the junction to provide thermal tempering.

D-2 Results

Outputs from two thermocouples made from the same part of the spools agreed to within 1 μV. Thermocouples made from different sections of the spools showed a maximum variation of 5.7 μV, as shown in Table D-1. The readings in Table D-1 show the voltage generated by the temperature difference between an electronic ice bath and LN_2. The ice bath was

shown to vary from a real ice bath by a constant amount; therefore, the readings in this table are slightly different from readings taken elsewhere in the calibration.

Table D-1

OUTPUT OF THERMOCOUPLES MADE FROM DIFFERENT SECTIONS OF SPOOLS

(LN_2 AND ELECTRONIC ICE BATH)

Section of Each Spool	First Reading (μV)	Second Reading (μV)	Third Reading (μV)	Fourth Reading (μV)
Front	8691.4	8691.9	8692.2	8692.0
Center	8693.0	8692.7	8691.9	8692.0
End	8687.3	8688.0	8687.3	8688.4

After the measurements in Table D-1 were taken, one thermocouple made from wire taken from the center of each spool was checked over a four-day period with a new supply of LN_2 and a new ice bath each day. The LN_2 temperature was corrected for changes in barometric pressure over the four-day period. The data, given in Table D-2, show the maximum variation of this thermocouple to be ± 0.9 μV.

Table D-2

DATA USED IN COMPUTING THERMOCOUPLE CALIBRATION TABLE

LN_2 Temperature[a] (°K)	Ice Bath Temperature (°K)	T/C Output (μV)
77.187	273.16	8700.0
77.187	273.16	8698.2
77.187	273.16	8698.3
77.187	273.16	8699.7
77.187	273.16	8700.0
		Avg 8699.24

[a]After correction for barometric pressure.

The values used in the NBS FACTOR program were the two temperatures 77.187°K and 273.16°K and the average thermocouple output for the four-day period, 8699.24μV.

D-3 Accuracy

The contributing factors to the accuracy of the calibration are:

1. Differences between T/Cs made from various sections of the spools. This was shown to be 5.7μV, or $\pm$2.85μV.

2. Variations in thermocouple output over a period of time. This was shown to be 1.8μV, or $\pm$0.9μV.

3. Accuracy of temperature of ice bath and LN_2 bath. The ice bath was made from distilled water and crushed ice made from distilled water. It was stirred with a Rosemount ice bath stirrer, which, according to the manufacturer, has an accuracy of $\pm$0.002°F, or, converting to usable terms, $\pm$0.03μV. The accuracy of the temperature of LN_2

depends upon the accuracy of the barometer used to measure the pressure; this is taken as $\pm 0.1\%$ or, converting to microvolts, $\pm 0.21\ \mu V$.

4. Accuracy of voltage-measuring device. A Rubicon potentiometer, tertiary standard Model 2768 with an accuracy of $\pm 0.01\%$ of reading plus $0.1\ \mu V$, was used. For the range used, this gives an accuracy of $\pm 0.97\ \mu V$.

   The RSS accuracy then is (using maximum variations)

$$\left[(2.85)^2 + (0.9)^2 + (0.03)^2 + (0.21)^2 + (0.97)^2\right]^{1/2} = \pm 2.93\ \mu V$$

   This is equivalent to $\pm 0.108^{\circ}K$ at LN_2 temperature.

T/C sample (microvolts)	The emf output of the grounded thermocouple embedded in the lid on the centerline of the specimen diameter at the specified ΔT
T/C ring (microvolts)	The emf output of the grounded thermocouple embedded in the lid on the centerline of the rim of the reference ring at the specified ΔT
Specimen current (amperes)	The current through the specimen heater at the specified ΔT
Specimen voltage (volts)	The voltage across the specimen heater at the specified ΔT
Shield voltage (volts)	The voltage across the shield heater at the specified ΔT
Vacuum (mm-Hg)	The vacuum inside the thermal conductivity unit at time of data cycle
Barometric Pressure (mm-Hg)	The barometric pressure at the time of the data cycle
Resistance Fwd (microvolts)	The emf output between T/C 1 and T/C 3 (140-mm specimen length) with current flow through the specimen
Volts Forward (microvolts)	The forward voltage drop across a 9.745-Ω resistor in the resistivity test circuit. From this the current through the specimen is equal to E/R
Resistance Rev. (microvolts)	The emf output between T/C 1 and T/C 3 (140-mm specimen length) with reverse current flow through the specimen

APPENDIX E

THERMAL CONDUCTIVITY/ELECTRICAL RESISTIVITY TEST 37/R104 RAW EXPERIMENTAL DATA

The experimental data for the thermal conductivity/electrical resistivity test are presented in Tables E-1 through E-15. An explanation of the data appearing in these tables is presented below.

Differential Temperature	The approximate temperature gradient in ^{o}K across the specimen
T/C 1 (microvolts)	The emf output of the ungrounded top specimen thermocouple at the ΔT specified
T/C 2 (microvolts)	The emf output of the ungrounded middle specimen thermocouple at the ΔT specified
T/C 3 (microvolts)	The emf output of the ungrounded bottom specimen thermocouple at the ΔT specified
T/C 4 (microvolts)	The emf output of the ungrounded differential thermocouple between the shield and the specimen at the location of T/C 3
T/C 5 (microvolts)	The emf output of the ungrounded thermocouple located on top of the unit lid at the specified ΔT

Volts Reverse (volts)	The reverse voltage drop across the 9.745-Ω resistor in the resistivity circuit. From this the current through the specimen is equal to E/R
Thermoelectric Power (microvolts)	The emf output across 140 mm of specimen length with no current flow

Table E-1

PREIRRADIATION DATA FOR ALUMINUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	16.1	32.0	61.9	79.1	133.9	161.3	166.8	177.3	194.1	210.4
T/C 1 (μV)	-1.5	105.1	226.3	496.5	678.0	1380.2	1803.6	1895.8	2070.0	2370.4	2669.9
T/C 2 (μV)	0.9	337.0	723.0	1592.4	2178.0	4430.4	5766.9	6051.0	6595.0	7516.0	8436.0
T/C 3 (μV)	-0.7	571.0	1238.0	2756.6	3779.5	7683.6	9980.1	10464.0	11390.2	12951.0	14501.4
T/C 4 (μV)	0	0.25	-1.0	-1.1	-2.5	5.5	-10.6	1.5	-7.0	-0.6	-3.6
T/C 5 (μV)	0	-1.0	-1.0	0.1	0	1.2	2.1	1.0	1.5	2.25	2.0
Specimen Current (A)	0	0.05218	0.07586	0.11059	0.12836	0.18068	0.20579	0.21056	0.21978	0.23491	0.24943
Specimen Voltage (V)	0	3.0692	4.4738	6.5428	7.5950	10.672	12.137	12.415	12.958	13.831	14.675
Shield Current (A)	0	0.04117	0.05923	0.08624	0.09992	0.14151	0.16180	0.16602	0.17335	0.18664	0.19945
Shield Voltage (V)	0	25.345	36.566	53.397	61.899	87.538	99.96	102.50	107.10	115.11	122.94
Vacuum (mm-Hg)	1.5 ATM He	3.98×10^{-5}	4.2×10^{-5}	4.4×10^{-5}	4.5×10^{-5}	5.0×10^{-5}	4.8×10^{-5}	3.25×10^{-5}	3.0×10^{-5}	5.0×10^{-5}	5.0×10^{-5}
Bar. Pressure (mm-Hg)	745.5	744.0	744.0	742.0	747.0	745.2	742.1	747.2	746.6	746.0	748.9
T/C in Sample (μV)	-0.1	-0.5	-1.0	1.5	1.5	1.0	3.8	3.0	1.1	4.75	3.3
T/C in Ring (μV)	0	-0.6	-1.2	1.2	0.5	0.5	4.3	1.5	2.1	10.0	7.2
Resistance Fwd (μV)	91.1	152.6	0.0	318.7	380.3	584.0	707.9	732.2	779.0	859.6	940.2
Voltage Fwd (V)	4.8510	4.871	4.8712	4.8700	4.8753	4.6746	4.8765	4.8751	4.8700	4.8714	4.8734
Resistance Rev (μV)	-95.2	-45.0	211.3	80.4	126.3	287.2	370.0	388.0	425.5	488.0	552.0
Voltage Rev (V)	4.8805	4.870	4.8720	4.8755	4.8700	4.6788	4.8731	4.8940	4.8700	4.8757	4.8733
Thermoelectric Pwr (μV)	-1.6	53.0	106	- 199.7	253.5	435.7	539.0	560.5	602.5	674.0	746.3
Run Information											
Run No.	21	24	25	26	27	28	29	23	22	30	31
Time	2055	1945	0631	2332	0640	0455	2103	0653	1134	0651	1905
Date (1967)	Oct 2	Oct 5	Oct 6	Oct 6	Oct 8	Oct 9	Oct 9	Oct 5	Oct 4	Oct 10	Oct 10

Table E-2

POSTIRRADIATION DATA FOR ALUMINUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	15.7	31.0	58.2	79.6	128.2	155.9	161.4	170.8	189.3	206.8
T/C 1 (μV)	0	106.3	224.0	472.6	708	1345.6	1753.6	1836.9	1986	2294.6	2607.0
T/C 2 (μV)	2.5	334.5	705.6	1497.5	2246.0	4274.3	5587.4	5856.1	6331	7300.6	8271.4
T/C 3 (μV)	2.5	565.0	1204.5	2573.2	3849.0	7320.6	9583.3	10044.5	10862	12517.6	14168.2
T/C 4 (μV)	1.3	-8.0	-1.5	8	3.0	4.5	0.0	1.4	-3	-8	0.0
T/C 5 (μV)	-3.0	-2.1	-1.0	2	5.1	6.4	8.4	7.2	8.6	9	6.5
Specimen Current (A)	0	0.05041	0.07269	0.10441	0.12715	0.17523	0.20180	0.20688	0.21578	0.23282	0.24937
Specimen Voltage (V)	0	2.9786	4.3038	6.1947	7.5410	10.360	11.908	12.202	12.717	13.702	14.653
Shield Current (A)	0	0.03937	0.05698	0.08160	0.09861	0.13581	0.15650	0.16060	0.16776	0.18189	0.19571
Shield Voltage (V)	0	24.354	35.326	50.682	61.243	84.148	96.750	99.220	103.55	112.10	120.47
Vacuum (mm-Hg)	$5x10^{-5}$	$6x10^{-5}$	$7x10^{-5}$	$6.5x10^{-5}$	$1.7x10^{-5}$	$5x10^{-5}$	$1.6x10^{-5}$	$1.7x10^{-5}$	$1.7x10^{-5}$	$1.8x10^{-5}$	$4.4x10^{-5}$
Bar. Pressure (mm-Hg)	754.0	754.4	753.8	755	755	753	753	753	750	749	746
T/C in Sample (μV)	-0.6	-2.5	-0.4	4.4	-2.1	15.4	10.9	12.1	19.2	21	21.6
T/C in Ring (μV)	0.0	0.0	-0.5	0.7	-3.8	13.1	8.5	8.1	17.0	18.1	20.5
Resistance Fwd (μV)	100.0	154.5	207.2	300.4	376.0	562.7	681.1	605.4	748	834.6	920.7
Voltage Fwd (V)	4.8720	4.8727	4.8734	4.8738	4.8744	4.8758	4.8773	4.8763	4.8743	4.8703	4.8747
Resistance Rev (μV)	-100.0	-56.4	-17.0	52	108.8	250	341.4	360	394	462.0	531.3
Voltage Rev (V)	4.8718	4.8722	4.8739	4.8759	4.8723	4.8779	4.8762	4.8741	4.8748	4.8771	4.8744
Thermoelectric Pwr (μV)	0.0	48.7	94.8	176	242	406.4	511.6	532.8	571.2	647.7	726.0
Run Information											
Run No.	P_2-3	P_2-4	P_2-5	P_2-6	P_2-7	P_2-8	P_2-9	P_2-10	P_2-11	P_2-12	P_2-13
Time	1900	1435	0133	1228	0730	1533	2330	0430	1330	1853	0430
Date (1967)	Nov 5	Nov 6	Nov 7	Nov 7	Nov 8	Nov 8	Nov 8	Nov 9	Nov 9	Nov 9	Nov 10

Table E-3

POSTIRRADIATION DATA FOR ANNEALED ALUMINUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	15.9	31.9	61.7	78.7	133.5	160.4	166.19	176.7	192.9	209.6
T/C 1 (μV)	-0.3	103.5	225.7	492.9	675.0	1375.6	1792	1890.0	2065.0	2350.4	2652.7
T/C 2 (μV)	1.4	332.0	721.9	1587.5	2167.5	4417.4	5734.0	6031.5	6575.9	7458.8	8395.0
T/C 3 (μV)	2.4	564.5	1238.4	2750.4	3759.0	7657.7	9919.4	10423.7	11353.7	12850.0	14431.3
T/C 4 (μV)	0	-3.0	5.4	-2.1	-3.9	-0.8	3.0	-1.5	0.1	-4.1	3.1
T/C 5 (μV)	-1.2	-4.0	-2.2	1.6	-1.1	4.5	2.0	3.0	5.9	4.0	10.0
Specimen Current (A)	0	0.05218	0.07593	0.11075	0.12826	0.18071	0.20550	0.21070	0.22009	0.23464	0.24946
Specimen Voltage (V)	0	3.0650	4.4724	6.5407	7.5778	10.660	12.104	12.407	12.952	13.797	14.655
Shield Current (A)	0	0.04139	0.05964	0.08644	0.09962	0.14018	0.16047	0.16473	0.17264	0.18503	0.19803
Shield Voltage (V)	0	25.433	36.755	53.430	61.620	86.590	98.997	101.58	106.41	113.96	121.90
Vacuum (mm-Hg)	3.45×10^{-4}	3.25×10^{-4}	2.9×10^{-4}	3.2×10^{-4}	1.15×10^{-4}	1.35×10^{-4}	1.35×10^{-4}	1.25×10^{-4}	1.15×10^{-4}	1.35×10^{-4}	1.19×10^{-4}
Bar. Pressure (mm-Hg)	-	747	746.2	749	748	750.2	748.8	750.0	749.2	750.0	747
T/C in Sample (μV)	-4.4	0	1.0	3.6	0	7.9	8.0	9.1	17.5	21.5	22
T/C in Ring (μV)	-4.0	0	1.5	3.9	0	6.6	9.0	10.0	16.4	19.4	19.6
Resistance Fwd (μV)	93	151.7	212.6	318.4	379.6	590.3	706.5	731.6	779.6	856.8	939.6
Voltage Fwd (V)	4.8790	4.8720	4.8712	4.8799	4.8742	4.8729	4.8718	4.8752	4.8746	4.8710	4.8700
Resistance Rev (μV)	-94	-66.3	0	79.5	125.3	280.6	368	383.7	421.3	485.5	551.1
Voltage Rev (V)	4.8780	4.8727	4.8700	4.8770	4.8752	4.8747	4.8719	4.8716	4.8731	4.8779	4.8721
Thermoelectric Pwr (μV)	0	52.8	105.9	199.2	252.1	435.2	538.0	560	602.6	671.4	745.3
Run Information											
Run No.	P_3-1	P_3-2	P_3-3	P_3-4	P_3-5	P_3-6	P_3-7	P_3-8	P_3-9	P_3-10	P_3-11
Time	0921	1532	0033	0830	1934	0730	1328	2236	0430	0939	1430
Date (1967)	Nov 13	Nov 13	Nov 14	Nov 14	Nov 14	Nov 15	Nov 15	Nov 15	Nov 16	Nov 16	Nov 16

Table E-4

PREIRRADIATION DATA FOR NBS BERYLLIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	7.9	28.2	53.7	84.8	98.8	114.2				
T/C 1 (μV)	-1.1	42.2	175.3	350.0	556.3	644.5	736.8				
T/C 2 (μV)	1.4	152.3	612.3	1234.5	2030.5	2396.0	2794.0				
T/C 3 (μV)	-1.5	256.7	1056.9	2217.5	3860.7	4670.4	5591.0				
T/C 4 (μV)	4.4	-6.3	2.0	-0.1	-2.0	-8.6	-0.5				
T/C 5 (μV)	-2.5	-0.5	1.0	2.0	-1.0	0.0	2.1				
Specimen Current (A)	0	0.10226	0.20277	0.28165	0.35114	0.37398	0.39844				
Specimen Voltage (V)	0	1.2910	2.5783	3.6016	4.4960	4.7891	5.1008				
Shield Current (A)	0	0.19975	0.39669	0.54035	0.65300	0.69618	0.7335				
Shield Voltage (V)	0	32.660	65.475	89.554	108.27	115.54	121.53				
Vacuum (mm-Hg)		1.3×10^{-6}	7.8×10^{-7}	1.05×10^{-6}	4.3×10^{-7}	2.2×10^{-8}	5.5×10^{-8}				
Bar. Pressure (mm-Hg)		746.5	746.0	747.0	747.6	742.1	744.5				
T/C in Sample (μV)	Open	Open	Open	Open	Open	Open	Open				
T/C in Ring (μV)	0.5	3.5	4.0	5.5	7.5	8.6	8.1				
Resistance Fwd (μV)	69.5	112.5	224.9	346.0	469.0	517.9	565.9				
Voltage Fwd (V)	4.8735	4.8700	4.8733	4.8700	4.8702	4.8750	4.8757				
Resistance Rev (μV)	-71.5	-30.0	71.0	173.8	264.0	294.6	322.3				
Voltage Rev (V)	4.8749	4.8700	4.8741	4.8700	4.8730	4.8741	4.867				
Thermoelectric Pwr (μV)	-0.7	41.4	148.2	260	366.6	406.6	444.0				
Run Information											
Run No.	18	20	21	22	23	24	25				
Time	0411	1250	0335	1433	0939	1816	1813				
Date (1967)	Oct 3	Oct 3	Oct 4	Oct 4	Oct 5	Oct 8	Oct 9				

Table E-5

POSTIRRADIATION DATA FOR NBS BERYLLIUM SPECIMEN

Measurement	Differential Temperature, ΔT (°K)										
	0	7.7	26.9	51.5	83.0	0	50.9	82.4	103.4		
T/C 1 (μV)	0	41	162.5	342	584.5	0.0	342.6	582	750.8		
T/C 2 (μV)	1.6	150	579.0	1221	2128.5	1.7	1217.4	2117.5	2782.6		
T/C 3 (μV)	1.5	254	989.2	2122	3830.4	1.6	2106.8	3800	5073.0		
T/C 4 (μV)	0	3.6	5.8	2.6	-0.5	-0.1	-3.6	0.2	2.2		
T/C 5 (μV)	0	-1	2.1	2.4	9.4	0.0	7.0	17	21.4		
Specimen Current (A)	0	0.07525	0.14758	0.21142	0.27667	0	0.21237	0.27550	0.31227		
Specimen Voltage (V)	0	0.9564	1.8871	2.7162	3.5553	0	2.7224	3.5403	4.0100		
Shield Current (A)	0	0.13911	0.27228	0.39567	0.51482	0	0.40150	0.51409	0.57834		
Shield Voltage (V)	0	22.905	45.183	65.735	85.615	0	66.636	85.477	96.037		
Vacuum (mm-Hg)	3.9×10^{-6}	4.5×10^{-6}	5.5×10^{-5}	5.5×10^{-5}	2.15×10^{-5}	1.15×10^{-5}	5×10^{-6}	1×10^{-5}	1.7×10^{-5}		
Bar. Pressure (mm-Hg)	754	753.5	753.5	755.8	753.9	753	752.7	750	748		
T/C in Sample (μV)	Open	Open	Open	Open	Open	Open	Open	Open	Open		
T/C in Ring (μV)	3.0	5.6	9.1	16.0	22.5	2.9	25.0	19.0	17.9		
Resistance Fwd (μV)	121.6	134.5	166.9	200.5	235.9	118.4	199.8	235.2	260.7		
Voltage Fwd (V)	4.8754	4.8708	4.8727	4.8742	4.8755	4.8761	4.8741	4.8767	4.8720		
Resistance Rev (μV)	-121.8	-110.1	-88.5	-74.5	-72.9	-118.6	-69.4	-71.8	-72.5		
Voltage Rev (V)	4.8714	4.8707	4.8728	4.8718	4.8752	4.8743	4.8755	4.8723	4.8750		
Thermoelectric Pwr (μV)	0.0	11.8	39.0	62.4	80.6	0	69.5	81.0	93.1		
Run Information											
Run No.	P_2-3	P_2-4	P_2-5	P_2-6	P_2-7	P_2-8	P_2-9	P_2-10	P_2-11		
Time	1904	1445	0142	1135	0334	1733	0442	1430	2233		
Date (1967)	Nov 5	Nov 6	Nov 7	Nov 7	Nov 8	Nov 8	Nov 9	Nov 9	Nov 9		

Table E-6

POSTIRRADIATION DATA FOR ANNEALED NBS BERYLLIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	7.8	28.2	52.9	81.7	115.0					
T/C 1 (μV)	0	42.0	177.8	351.5	546.4	754.0					
T/C 2 (μV)	1.0	157.4	608.4	1224.5	1966.0	2834.6					
T/C 3 (μV)	0.5	256.9	1050.4	2194.5	3718.6	5676.6					
T/C 4 (μV)	0	5.4	-4.4	-4.3	10	-2.0					
T/C 5 (μV)	-2.4	-1.4	3.2	11.6	5.0	13.0					
Specimen Current (A)	0	0.10212	0.20200	0.28063	0.34681	0.40268					
Specimen Voltage (V)	0	1.2889	2.5688	3.5864	4.4418	5.1436					
Shield Current (A)	0	0.19985	0.38180	0.52283	0.63166	0.72569					
Shield Voltage (V)	0	32.688	63.081	86.730	104.92	120.17					
Vacuum (mm-Hg)	3.5×10^{-6}	1.2×10^{-7}	3.5×10^{-8}	5.0×10^{-8}	2×10^{-8}	8×10^{-7}					
Bar. Pressure (mm-Hg)	751.5	747	746	748.2	747.2	749.3					
T/C in Sample (μV)	Open	Open	Open	Open	Open	Open					
T/C in Ring (μV)	0	7.6	12.0	17.7	27	32.6					
Resistance Fwd (μV)	71	112.1	223.2	342.6	460.0	570.4					
Voltage Fwd (V)	4.8780	4.8758	4.8725	4.8708	4.8728	4.8758					
Resistance Rev (μV)	-70.6	-31.8	68.9	170.6	257.6	322.5					
Voltage Rev (V)	4.8790	4.8731	4.8715	4.8723	4.8750	4.8718					
Thermoelectric Pwr (μV)	0	39.9	145.7	256.2	359.0	446.4					
	Run Information										
Run No.	P_3-1	P_3-2	P_3-3	P_3-4	P_3-5	P_3-6					
Time	0855	1422	0042	0731	1432	0634					
Date (1967)	Nov 13	Nov 13	Nov 14	Nov 14	Nov 14	Nov 15					

Table E-7

PREIRRADIATION DATA FOR WANL BERYLLIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	15.1	30.3	64.6	85.5						
T/C 1 (μV)	1.4	82.8	171.75	371.5	478.0						
T/C 2 (μV)	0	297.9	630.0	1420.8	1896.4						
T/C 3 (μV)	1.2	515.5	1115.0	2706.2	3784.5						
T/C 4 (μV)	0	-8.6	-6.4	0	-9.5						
T/C 5 (μV)	-0.9	2.7	5.0	5.9	9.25						
Specimen Current (A)	0	0.21850	0.31260	0.45099	0.51046						
Specimen Voltage (V)	0	2.4056	3.4662	5.0470	5.7256						
Shield Current (A)	0	0.23064	0.33326	0.48500	0.54547						
Shield Voltage (V)	0	37.233	54.121	79.226	89.245						
Vacuum (mm-Hg)	1.5 ATM	$4.1x10^{-8}$	$4x10^{-8}$	$5x10^{-8}$	$3x10^{-8}$						
Bar. Pressure (mm-Hg)	745.4	742.1	748	750	749						
T/C in Sample (μV)	-3.4	2.1	15.0	4.0	3.25						
T/C in Ring (μV)	-2.7	0.4	10.0	19.1	20.0						
Resistance Fwd (μV)	32.1	99.6	163.8	280.8	336.6						
Voltage Fwd (V)	4.8700	4.8773	4.8741	4.8753	4.8738						
Resistance Rev (μV)	-30.0	34.4	93.0	194.2	236.0						
Voltage Rev (V)	4.8710	4.8735	4.8700	4.8758	4.8761						
Thermoelectric Pwr (μV)	+0.6	67.0	128.5	237.0	286.4						
Run Information											
Run No.	20	28	31	32	33						
Time	2100	2110	0956	0347	1350						
Date (1967)	Oct 2	Oct 9	Oct 10	Oct 11	Oct 11						

Table E-8

POSTIRRADIATION DATA FOR WANL BERYLLIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	14.6	29.8	62.1	78.9	0	61.2	78.5			
T/C 1 (μV)	0.5	79.9	176.7	402	522.0	1.0	397.1	518			
T/C 2 (μV)	0	293.2	647.1	1494	1973.0	0	1475.3	1961.2			
T/C 3 (μV)	1.4	497.1	1105.6	2640	3551.0	1.7	2594.4	3527.3			
T/C 4 (μV)	0	-8.9	1.6	3.5	-0.4	0	0	0			
T/C 5 (μV)	-2.5	-0.6	5.4	6.0	15.6	0	12.2	8.6			
Specimen Current (A)	0	0.14465	0.21360	0.31907	0.36475	0	0.31857	0.36385			
Specimen Voltage (V)	0	1.6045	2.3856	3.5923	4.1111	0	3.5815	4.1007			
Shield Current (A)	0	0.16137	0.24207	0.36629	0.41775	0	0.36760	0.41701			
Shield Voltage (V)	0	26.215	39.540	60.045	68.476	0	60.166	68.336			
Vacuum (mm-Hg)	$4x10^{-6}$	$6.5x10^{-6}$	$6x10^{-5}$	$5.1x10^{-5}$	$1.5x10^{-5}$	$1x10^{-5}$	$8.0x10^{-6}$	$1.05x10^{-5}$			
Bar. Pressure (mm-Hg)	754	753.5	753.7	755	754.5	753.1	753.1	750.0			
T/C in Sample (μV)	-4.0	0.	8.1	10.8	19.0	-6.6	9.6	14.0			
T/C in Ring (μV)	-3.4	0	6.6	7.0	18.2	-2.7	8.0	14.0			
Resistance Fwd (μV)	73.4	90.5	106.4	130.0	140.1	71.9	129.7	140.0			
Voltage Fwd (V)	4.8740	4.8730	4.8723	4.8760	4.8733	4.8718	4.8771	4.8747			
Resistance Rev (μV)	-71.0	-57.4	-47.6	-42.7	-44.5	-70.0	-40.0	-43.7			
Voltage Rev (V)	4.8722	4.8710	4.8714	4.8754	4.8770	4.8720	4.8727	4.8723			
Thermoelectric Pwr (μV)	1.0	16.0	29.0	43.2	47.4	0.7	44.1	47.2			
Run Information											
Run No.	P_2-3	P_2-4	P_2-5	P_2-6	P_2-7	P_2-8	P_2-9	P_2-10			
Time	1909	1454	2234	1231	0625	1832	0127	1439			
Date (1967)	Nov 5	Nov 6	Nov 6	Nov 7	Nov 8	Nov 8	Nov 9	Nov 9			

Table E-9

POSTIRRADIATION DATA FOR ANNEALED WANL BERYLLIUM SPECIMEN

Measurement	Differential Temperature, ΔT (°K)										
	0	15.0	29.1	62.4	83.4						
T/C 1 (μV)	0.5	83.0	167.6	368.0	477.4						
T/C 2 (μV)	0	297.0	604.9	1375.6	1858.7						
T/C 3 (μV)	0.5	514.2	1067.1	2599.7	3685.3						
T/C 4 (μV)	0	5.8	1.2	9.2	5.5						
T/C 5 (μV)	-3.5	-3.0	7.6	6.0	7.0						
Specimen Current (A)	0	0.21780	0.30600	0.44467	0.50686						
Specimen Voltage (V)	0	2.4056	3.4030	4.9892	5.7007						
Shield Current (A)	0	0.21132	0.29566	0.43015	0.48566						
Shield Voltage (V)	0	34.152	48.060	70.408	79.634						
Vacuum (mm-Hg)	$2x10^{-4}$	$3.5x10^{-8}$	$3.5x10^{-8}$	$3x10^{-8}$	$4x10^{-8}$						
Bar. Pressure (mm-Hg)	751.3	746.5	747.0	749.1	747.0						
T/C in Sample (μV)	-3.0	-0.5	6.9	15	2.1						
T/C in Ring (μV)	-3.0	-0.5	5.6	10	22.2						
Resistance Fwd (μV)	32.5	99.4	158.4	274.4	332.0						
Voltage Fwd (V)	4.8730	4.8703	4.8766	4.8720	4.8758						
Resistance Rev (μV)	-30.4	33.0	88.1	187.6	232.6						
Voltage Rev (V)	4.8703	4.8721	4.8748	4.8782	4.8738						
Thermoelectric Pwr (μV)	0.6	67.2	123.8	231.8	282.7						
Run Information											
Run No.	P_3-2	P_3-3	P_3-4	P_3-5	P_3-6						
Time	0727	1945	0337	1133	1652						
Date (1967)	Nov 13	Nov 13	Nov 14	Nov 14	Nov 14						

Table E-10

PREIRRADIATION DATA FOR GRAPHITE SPECIMEN

Measurement	Differential Temperature, ΔT (^{o}K)										
	0	15.1	48.2	121.5	135.2	173.7	187.6	207.7			
T/C 1 (μV)	0	137.5	638.3	2237.0	2530.7	3405.6	3696.0	4036.0			
T/C 2 (μV)	-0.6	364.2	1559.0	5313.5	6069.2	8264.5	9034.6	10063.0			
T/C 3 (μV)	1.0	578.5	2383.1	8266.0	9521.2	13217.4	14554.8	16416			
T/C 4 (μV)	0	-7.0	-1.1	-8.5	-4.3	2.9	8.4	0.4			
T/C 5 (μV)	0	0.5	2.4	1.3	2.2	8.0	10.4	0.6			
Specimen Current (A)	0	0.12934	0.28909	0.60900	0.66579	0.81916	0.87530	0.96081			
Specimen Voltage (V)	0	1.7623	3.9696	8.3190	9.0835	11.148	11.896	13.037			
Shield Current (A)	0	0.10826	0.23533	0.43144	0.45873	0.52861	0.55165	0.57851			
Shield Voltage (V)	0	16.798	36.926	68.351	72.756	83.892	87.655	92.035			
Vacuum (mm-Hg)	1.5ATM	1.75×10^{-4}	8×10^{-5}	8×10^{-5}	7.75×10^{-5}	7.5×10^{-5}	7×10^{-5}	7.5×10^{-5}			
Bar. Pressure (mm-Hg)	745.4	747.0	742.0	744.0	746.2	745.0	742.1	746.0			
T/C in Sample (μV)	3.9	3.0	0.6	3.5	1.5	7.0	6.3	2.7			
T/C in Ring (μV)	2.9	-1.0	11.7	3.9	27.0	49.6	50.6	31.2			
Resistance Fwd (μV)	3600	3592.5	3427.7	3089.0	3034.5	2953.6	2892.5	2845.5			
Voltage Fwd (V)	0.9766	0.9826	0.9755	0.9774	0.9790	0.9881	0.9782	0.9718			
Resistance Rev (μV)	-3615	-3469	-3084.2	-2495.0	-2417.9	-2252.4	-2156.8	-2059.6			
Voltage Rev (V)	0.9762	0.9833	0.9745	0.9733	0.9745	0.9877	0.9778	0.9733			
Thermoelectric Pwr (μV)	-1.4	63.3	169.7	292.0	306.3	348.0	365.6	394.4			
Run Information											
Run No.	14	16	19	20	15	22	23	21			
Time	2103	0728	0038	1245	0140	0606	1700	0439			
Date (1967)	Oct 2	Oct 5	Oct 7	Oct 7	Oct 4	Oct 9	Oct 9	Oct 8			

Table E-11

POSTIRRADIATION DATA FOR GRAPHITE SPECIMEN

Measurement	Differential Temperature, ΔT ($^{\circ}K$)										
	0	17.2	50.4	117.8	133.4	195.5					
T/C 1 (μV)	-63.4	102.6	518.1	1778	2178.1	4291.8					
T/C 2 (μV)	-64.4	363.3	1472.6	4825	5833.4	10882.7					
T/C 3 (μV)	-60.0	614.1	2337.6	7422	8904.6	15973.0					
T/C 4 (μV)	15	7.4	1.4	-1.0	3.2	-6.1					
T/C 5 (μV)	0	0.5	0.8	3.8	3.6	6.5					
Specimen Current (A)	0	0.07213	0.15220	0.32854	0.37537	0.58741					
Specimen Voltage (V)	0	0.9894	2.1020	4.504	5.1340	7.9570					
Shield Current (A)	0	0.04883	0.09836	0.19068	0.21509	0.33022					
Shield Voltage (V)	0	7.6510	15.561	30.287	34.156	52.369					
Vacuum (mm-Hg)	9×10^{-5}	8.8×10^{-5}	1×10^{-4}	1.5×10^{-5}	1.6×10^{-5}	1.7×10^{-5}					
Bar. Pressure (mm-Hg)	754.0	753.5	754.5	755.0	753.5	749.6					
T/C in Sample (μV)	0	-0.4	-0.1	4.0	0	1.4					
T/C in Ring (μV)	3.0	3.0	4.5	14.2	10.0	18.9					
Resistance Fwd (μV)	5411.0	5359.0	5062.9	3705.2	3161.7	714.4					
Voltage Fwd (V)	0.9720	0.9753	0.9727	0.9758	0.9773	0.9746					
Resistance Rev (μV)	-5409	-5458.9	-5567.9	-6217.0	-6535.1	-7756.4					
Voltage Rev (V)	0.9713	0.9753	0.9783	0.9708	0.9733	0.9740					
Thermoelectric Pwr (μV)	0	-49.0	-237.2	-1263.0	-1693.6	-3516.8					
Run Information											
Run No.	P_2-3	P_2-13	P_2-14	P_2-15	P_2-16	P_2-17					
Time	1912	0254	1441	0742	0029	1456					
Date (1967)	Nov 5	Nov 7	Nov 7	Nov 8	Nov 9	Nov 9					

Table E-12

POSTIRRADIATION DATA FOR ANNEALED GRAPHITE SPECIMEN

Measurement	Differential Temperature, ΔT (°K)										
	0	15.6	49.6	119.3	131.1	190.1					
T/C 1 (μV)	-3.6	126.0	626.6	2118.2	2405.0	3908.4					
T/C 2 (μV)	-1.5	377.0	1642.5	5421.2	6155.6	10078.4					
T/C 3 (μV)	0	583.5	2424.2	7974.1	9072.0	15028.2					
T/C 4 (μV)	3.4	9.5	12.0	-4.3	-2.7	6.9					
T/C 5 (μV)	-0.8	-7.5	0	4.5	5.6	10.5					
Specimen Current (A)	0	0.07520	0.16758	0.36025	0.39356	0.56943					
Specimen Voltage (V)	0	1.0182	2.2892	4.9173	5.3645	7.7146					
Shield Current (A)	0	0.05363	0.11349	0.21845	0.23507	0.32426					
Shield Voltage (V)	0	8.2991	17.782	34.530	37.204	51.406					
Vacuum (mm-Hg)	4.7×10^{-4}	7×10^{-4}	7×10^{-4}	-	4.8×10^{-4}	5×10^{-4}					
Bar. Pressure (mm-Hg)	746	746.5	748.2	749.3	748.8	750.0					
T/C in Sample (μV)	-1.8	1.0	-1.4	0	0	0					
T/C in Ring (μV)	1.4	-2.5	3.6	10.9	11.4	16.5					
Resistance Fwd (μV)	4922.4	4728.4	4163.5	2489.0	2200.0	651.3					
Voltage Fwd (V)	0.9727	0.9710	0.9752	0.9729	0.9766	0.9738					
Resistance Rev (μV)	-4930.7	-5045.6	-5356.0	-6462.9	-6659.0	-7751.2					
Voltage Rev (V)	0.9731	0.9777	0.9752	0.9767	0.9727	0.9738					
Thermoelectric Pwr (μV)	-2.5	-140	-598.5	-1978.0	-2236.4	-3546.4					
Run Information											
Run No.	P_3-13	P_3-2	P_3-3	P_3-4	P_3-5	P_3-6					
Time	0230	2147	1644	0532	1427	0130					
Date (1967)	Nov 17	Nov 13	Nov 14	Nov 15	Nov 15	Nov 16					

Table E-13

PREIRRADIATION DATA FOR TITANIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^oK)										
	0	15.7	31.3	60.9	77.9	133.5	156.7	179.2	229.4		
T/C 1 (μV)	-0.4	118.4	254.0	541.5	728.0	1460.6	1837.0	2241.6	3354.5		
T/C 2 (μV)	2.4	346.2	742.4	1619.2	2201.5	4518.6	5698.75	6944.4	10248		
T/C 3 (μV)	4.2	576.1	1254.8	2780.7	3800.7	7794.0	9763.25	11782.2	16885		
T/C 4 (μV)	1.6	3.2	-11	1.0	7.0	-6.3	0	-7.7	-6.0		
T/C 5 (μV)	-2.1	-3.0	-1.4	-1.4	-1.6	-1.0	-1.6	6.2	0		
Specimen Current (A)	0	0.09212	0.13402	0.19353	0.22394	0.31582	0.35583	0.39391	0.48730		
Specimen Voltage (V)	0	1.2009	1.7548	2.5447	2.9467	4.1534	4.6750	5.1703	6.3837		
Shield Current (A)	0	0.01048	0.01715	0.02671	0.03269	0.05369	0.06390	0.07538	0.10733		
Shield Voltage (V)	0	6.6758	10.819	16.902	20.677	33.849	40.196	47.361	67.232		
Vacuum (mm-Hg)		1.65×10^{-6}	1.5×10^{-6}	5×10^{-8}	1.4×10^{-7}	2×10^{-7}	3×10^{-8}	7×10^{-8}	1.9×10^{-6}		
Bar. Pressure (mm-Hg)	746.0	747.5	747.6	745.3	745.5	743.5	745.5	747.5	744.5		
T/C in Sample (μV)	-0.5	0	0	0.5	0.6	4.0	4.5	7.9	7.0		
T/C in Ring (μV)	3.3	3.4	3.7	4.0	4.7	7.4	7.4	10.8	9.4		
Resistance Fwd (μV)	491.4	570.1	656.0	833.8	949.0	1392.0	1612.5	1841.9	2425.6		
Voltage Fwd (V)	4.8715	4.8700	4.8700	4.8721	4.8760	4.8750	4.8740	4.8718	4.8700		
Resistance Rev (μV)	-491.0	-422.0	-346.0	-189.5	-86.0	316.0	519.6	733.5	1282.6		
Voltage Rev (V)	4.8771	4.8700	4.8700	4.8755	4.8773	4.8796	4.8734	4.8720	4.8716		
Thermoelectric Pwr (μV)	0.1	74.0	155.0	321.8	429.7	853.6	1065.9	1287.2	1854.4		
Run Information											
Run No.	15	16	17	21	22	23	24	25	26		
Time	0403	0855	0925	0341	0200	0400	0655	2158	1445		
Date (1967)	Oct 3	Oct 4	Oct 5	Oct 8	Oct 9	Oct 10	Oct 11	Oct 11	Oct 12		

Table E-14

POSTIRRADIATION DATA FOR TITANIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^oK)										
	0	15.0	76.3	130.3	221.2						
T/C 1 (μV)	2.5	123	746	1488.0	3349.3						
T/C 2 (μV)	8.0	343.6	2195	4479.5	9923.3						
T/C 3 (μV)	11.6	568.2	3759	7654.6	16311						
T/C 4 (μV)	66.4	3.0	-1.4	-1.2	-6.6						
T/C 5 (μV)	-0.6	-2.0	1.0	1.6	2.4						
Specimen Current (A)	0	0.08990	0.22087	0.31208	0.47636						
Specimen Voltage (V)	0	1.1762	2.9122	4.1010	6.2152						
Shield Current (A)	0	0.0124	0.03330	0.05358	0.10545						
Shield Voltage (V)	0	6.4931	21.107	33.810	65.858						
Vacuum (mm-Hg)	$5x10^{-6}$	$3.7x10^{-6}$	$8x10^{-5}$	$6x10^{-5}$	$8x10^{-6}$						
Bar. Pressure (mm-Hg)	754.0	755.2	755.0	753.0	747.5						
T/C in Sample (μV)	Open	Open	Open	Open	Open						
T/C in Ring (μV)	3.5	3.0	4.5	4.5	9.2						
Resistance Fwd (μV)	495.5	444.8	944.7	1376.1	2352.9						
Voltage Fwd (V)	4.8763	4.8778	4.8709	4.8730	4.8768						
Resistance Rev (μV)	-491.2	-296.8	-92.6	293.1	1207.9						
Voltage Rev (V)	4.8728	4.8703	4.8761	4.8763	4.8753						
Thermoelectric Pwr (μV)	1.7	72.4	423.0	835.0	1780.5						
Run Information											
Run No.	P_2-3	P_2-4	P_2-5	P_2-6	P_2-7						
Time	1915	1340	0752	0330	2341						
Date (1967)	Nov 5	Nov 7	Nov 8	Nov 9	Nov 9						

Table E-15

POSTIRRADIATION DATA FOR ANNEALED TITANIUM SPECIMEN

Measurement	Differential Temperature, ΔT (^oK)										
	0	14.5	72.3	132.2	224.6						
T/C 1 (μV)	2.5	114.5	679.6	1475.5	3344.2						
T/C 2 (μV)	8.0	327.0	2027.3	4507.5	10065.2						
T/C 3 (μV)	11.6	541.6	3482.6	7742.6	16536						
T/C 4 (μV)	66.4	0	9.4	9.4	-6.1						
T/C 5 (μV)	-0.6	-2.0	-1.6	12.4	-3.5						
Specimen Current (A)	0	0.08892	0.21507	0.31522	0.48064						
Specimen Voltage (V)	0	1.1511	2.8156	4.1256	6.2690						
Shield Current (A)	0	0.00922	0.02978	0.05230	0.10392						
Shield Voltage (V)	0	5.8113	18.796	32.913	64.960						
Vacuum (mm-Hg)	$5x10^{-6}$	$4.5x10^{-6}$	$5x10^{-6}$	$5.5x10^{-6}$	$5.5x10^{-6}$						
Bar. Pressure (mm-Hg)	754.0	748.2	749.7	750.0	747						
T/C in Sample (μV)	Open	Open	Open	Open	Open						
T/C in Ring (μV)	3.5	2.5	3.0	3.6	7.1						
Resistance Fwd (μV)	495.5	565.6	914	1386.1	2383.0						
Voltage Fwd (V)	4.8763	4.8780	4.8741	4.8743	4.8718						
Resistance Rev (μV)	-491.2	-425.6	-121	306.9	1239.2						
Voltage Rev (V)	4.8728	4.8760	4.8743	4.8763	4.8723						
Thermoelectric Pwr (μV)	1.7	68.8	395.6	846.7	1811.7						
Run Information											
Run No.	P_2-3	P_3-2	P_3-3	P_3-4	P_3-5						
Time	1915	1247	0645	2340	1335						
Date (1967)	Nov 5	Nov 14	Nov 15	Nov 15	Nov 16						

APPENDIX F

THERMAL CONDUCTIVITY/ELECTRICAL RESISTIVITY TEST 37/R104 CALCULATED DATA

Tables F-1 through F-99 contain the data and calculations for k, Δk, ρ , $\Delta\rho$, and the Lorenz ratio. The "Input Data" were calculated from the raw experimental data in Appendix E and, then, processed by an IBM 360 computer. The methods used to process the data and definitions of the statistical terms are presented in Section III. Table F-100 is electrical resistivity data taken during irradiation.

A general rule to follow to determine a reasonable number of significant digits that are applicable to the various values listed in the following tables is to make a relative comparison between the value considered and its respective confidence limit. For example, a value of $\rho = 1.4996$ μohm-cm may be accurate to five significant digits, but with a confidence interval of 1.4938 and 1.5053 μohm-cm, ρ might well be limited to 1.500 $\pm$ 0.006 μohm-cm so far as inferences about the final results are concerned.

The data listed in the IBM E format is interpreted as follows:

$$1.55200\text{E } 02 = 1.552 \times 10^{2}$$
$$1.55200\text{E-}02 = 1.552 \times 10^{-2}$$

Table F-1

THERMAL CONDUCTIVITY OF ALUMINUM: PREIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (^{o}K)	Thermal Cond (W/cm-^{o}K)	Thermal Cond (W/cm-^{o}K)	Residuals (input-calc)	
8.1179990 01	8.678000E-01	8.607628E-01	7.037222E-03	1
8.5569990 01	8.927000E-01	8.847638E-01	7.936180E-03	2
8.9409990 01	9.020000E-01	9.051846E-01	-3.184617E-03	1
9.4969990 01	9.328000E-01	9.338014E-01	-1.001358E-03	3
9.7359990 01	9.339000E-01	9.457567E-01	-1.185673E-02	1
1.0090000D 02	9.612000E-01	9.630834E-01	-1.883388E-03	4
1.0220000D 02	9.658000E-01	9.693316E-01	-3.531575E-03	2
1.1770000D 02	1.023000E 00	1.039099E 00	-1.609898E-02	2
1.2750000D 02	1.098000E 00	1.078702E 00	1.929760E-02	3
1.4270000D 02	1.151999E 00	1.133219E 00	1.878071E-02	4
1.5680000D 02	1.160000E 00	1.176279E 00	-1.627922E-02	3
1.7990000D 02	1.231999E 00	1.231203E 00	7.963181E-04	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 2.90627E-01$

$C_2 = 8.49900E-03$

$C_3 = -1.81805E-05$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.303920E-02$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (^{o}K)	k (W/cm-^{o}K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	8.54192E-01	8.16583E-03	8.19422E-01	8.88962E-01	8.35737E-01	8.72647E-01
90.	9.08275E-01	5.19505E-03	8.76553E-01	9.39996E-01	8.96534E-01	9.20015E-01
100.	9.58721E-01	4.40104E-03	9.27619E-01	9.89823E-01	9.48775E-01	9.68668E-01
110.	1.00553E 00	5.15076E-03	9.73848E-01	1.03722E 00	9.93892E-01	1.01717E 00
120.	1.04871E 00	6.03631E-03	1.01623E 00	1.08118E 00	1.03506E 00	1.06235E 00
130.	1.08825E 00	6.50580E-03	1.05531E 00	1.12118E 00	1.07354E 00	1.10295E 00
140.	1.12415E 00	6.53267E-03	1.09119E 00	1.15711E 00	1.10938E 00	1.13891E 00
150.	1.15641E 00	6.42228E-03	1.12357E 00	1.18926E 00	1.14190E 00	1.17093E 00
160.	1.18505E 00	6.85827E-03	1.15175E 00	1.21834E 00	1.16955E 00	1.20054E 00
170.	1.21004E 00	8.62111E-03	1.17471E 00	1.24537E 00	1.19056E 00	1.22952E 00
180.	1.23140E 00	1.19426E-02	1.19144E 00	1.27136E 00	1.20441E 00	1.25839E 00

Table F-2

THERMAL CONDUCTIVITY OF ALUMINUM: POSTIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.129999D 01	8.260000E-01	8.217891E-01	4.210889E-03	1
8.529999D 01	8.444000E-01	8.414700E-01	2.929986E-03	2
8.939999D 01	8.620999E-01	8.613682E-01	7.317066E-04	1
9.439999D 01	8.807999E-01	8.852577E-01	-4.457772E-03	3
9.689999D 01	8.953000E-01	8.970474E-01	-1.747429E-03	1
1.016000D 02	9.176000E-01	9.189312E-01	-1.331270E-03	2
1.027000D 02	9.216000E-01	9.240001E-01	-2.400100E-03	4
1.167000D 02	9.744999E-01	9.867674E-01	-1.226741E-02	2
1.250000D 02	1.030999E 00	1.022447E 00	8.552551E-03	3
1.443000D 02	1.125999E 00	1.101007E 00	2.499294E-02	4
1.524000D 02	1.113000E 00	1.132140E 00	-1.914024E-02	3
1.806000D 02	1.231999E 00	1.232062E 00	-6.294250E-05	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 3.64391E-01

C_2 = 6.29877E-03

C_3 = -8.27456E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.188811E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	8.15336E-01	7.38663E-03	7.83705E-01	8.46967E-01	7.98642E-01	8.32030E-01
90.	8.64257E-01	4.72096E-03	8.35349E-01	8.93165E-01	8.53587E-01	8.74926E-01
100.	9.11523E-01	3.98210E-03	8.83189E-01	9.39857E-01	9.02523E-01	9.20522E-01
110.	9.57134E-01	4.63212E-03	9.28299E-01	9.85968E-01	9.46665E-01	9.67602E-01
120.	1.00109E 00	5.42841E-03	9.71555E-01	1.03063E 00	9.88822E-01	1.01336E 00
130.	1.04339E 00	5.87134E-03	1.01343E 00	1.07336E 00	1.03012E 00	1.05666E 00
140.	1.08404E 00	5.93727E-03	1.05400E 00	1.11407E 00	1.07062E 00	1.09746E 00
150.	1.12303E 00	5.89750E-03	1.09304E 00	1.15302E 00	1.10970E 00	1.13636E 00
160.	1.16036E 00	6.34350E-03	1.12991E 00	1.19082E 00	1.14603E 00	1.17470E 00
170.	1.19605E 00	7.93763E-03	1.16374E 00	1.22835E 00	1.17811E 00	1.21398E 00
180.	1.23007E 00	1.08928E-02	1.19363E 00	1.26651E 00	1.20545E 00	1.25469E 00

Table F-3

THERMAL CONDUCTIVITY OF ALUMINUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 4

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.1280000D 01	8.751000E-01	8.684704E-01	6.629586E-03	1
8.5780000D 01	8.925000E-01	8.921791E-01	3.208518E-04	2
8.9420000D 01	9.141999E-01	9.108852E-01	3.314793E-03	1
9.5009990D 01	9.327000E-01	9.387897E-01	-6.089687E-03	3
9.7230000D 01	9.513000E-01	9.495958E-01	1.704156E-03	1
1.0090000D 02	9.608999E-01	9.671147E-01	-6.214797E-03	4
1.0240000D 02	9.700000E-01	9.741513E-01	-4.151285E-03	2
1.1780000D 02	1.030999E 00	1.042250E 00	-1.125050E-02	2
1.2760000D 02	1.091000E 00	1.081651E 00	9.348869E-03	3
1.4250000D 02	1.153999E 00	1.135693E 00	1.830673E-02	4
1.5670000D 02	1.169000E 00	1.180612E 00	-1.161194E-02	3
1.7950000D 02	1.238999E 00	1.239295E 00	-2.956390E-04	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 3.29146E-01

C_2 = 7.93040E-03

C_3 = -1.59327E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 9.631675E-03

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	8.61609E-01	6.06699E-03	8.35883E-01	8.87335E-01	8.47897E-01	8.75320E-01
90.	9.13827E-01	3.84895E-03	8.90385E-01	9.37268E-01	9.05128E-01	9.22525E-01
100.	9.62858E-01	3.25267E-03	9.39883E-01	9.85834E-01	9.55507E-01	9.70209E-01
110.	1.00870E 00	3.80862E-03	9.85296E-01	1.03211E 00	1.00010E 00	1.01731E 00
120.	1.05136E 00	4.46390E-03	1.02737E 00	1.07535E 00	1.04127E 00	1.06145E 00
130.	1.09083E 00	4.80696E-03	1.06651E 00	1.11516E 00	1.07997E 00	1.10170E 00
140.	1.12712E 00	4.82100E-03	1.10278E 00	1.15146E 00	1.11622E 00	1.13801E 00
150.	1.16022E 00	4.73908E-03	1.13596E 00	1.18448E 00	1.14951E 00	1.17093E 00
160.	1.19013E 00	5.08076E-03	1.16552E 00	1.21474E 00	1.17865E 00	1.20161E 00
170.	1.21686E 00	6.42617E-03	1.19069E 00	1.24302E 00	1.20233E 00	1.23138E 00
180.	1.24040E 00	8.93353E-03	1.21071E 00	1.27009E 00	1.22021E 00	1.26059E 00

Table F-4

THERMAL CONDUCTIVITY OF ALUMINUM: CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.100000D 01	-4.224000E-02	-4.997770E-02	7.737700E-03	1
8.500000D 01	-4.666000E-02	-4.789902E-02	1.239017E-03	2
8.900000D 01	-4.005000E-02	-4.584269E-02	5.792692E-03	1
9.500000D 01	-4.787000E-02	-4.280014E-02	-5.069859E-03	3
9.700000D 01	-3.720000E-02	-4.179713E-02	4.597135E-03	1
1.020000D 02	-4.734000E-02	-3.931408E-02	-8.025918E-03	2
1.020000D 02	-4.847000E-02	-3.931408E-02	-9.155918E-03	4
1.170000D 02	-4.638000E-02	-3.207456E-02	-1.430544E-02	2
1.220000D 02	-3.210000E-02	-2.973126E-02	-2.368741E-03	5
1.260000D 02	-4.651000E-02	-2.788178E-02	-1.862822E-02	3
1.330000D 02	-1.570000E-02	-2.469899E-02	8.998994E-03	6
1.350000D 02	-1.210000E-02	-2.380221E-02	1.170221E-02	7
1.390000D 02	-3.780000E-03	-2.202540E-02	1.824540E-02	8
1.430000D 02	-3.207000E-02	-2.027095E-02	-1.179905E-02	4
1.460000D 02	1.400000E-03	-1.896979E-02	2.036979E-02	9
1.530000D 02	-3.859000E-02	-1.598267E-02	-2.260733E-02	3
1.540000D 02	1.020000E-02	-1.556152E-02	2.576152E-02	10
1.800000D 02	4.500000E-06	-5.102385E-03	5.106881E-03	4
1.900000D 02	-1.410000E-02	-1.331296E-03	-1.276879E-02	5
2.170000D 02	1.580000E-03	8.152902E-03	-6.572902E-03	6
2.220000D 02	6.379999E-03	9.797413E-03	-3.417414E-03	7
2.310000D 02	1.220000E-02	1.266948E-02	-4.694834E-04	8
2.490000D 02	2.120000E-02	1.807402E-02	3.125977E-03	9
2.490000D 02	1.930000E-02	1.807402E-02	1.225978E-03	5
2.660000D 02	1.470000E-02	2.276249E-02	-8.062493E-03	10
2.880000D 02	2.950000E-02	2.823043E-02	1.269568E-03	6
2.950000D 02	3.470000E-02	2.982835E-02	4.871648E-03	7
3.090000D 02	3.500000E-02	3.281881E-02	2.181187E-03	8
3.350000D 02	4.700000E-02	3.764569E-02	9.354305E-03	9
3.610000D 02	3.320000E-02	4.152789E-02	-8.327879E-03	10

Least Squares Fit Coefficients

$\Delta k = C_1 + C_2 T + C_3 T^2$

C_1 = -9.68822E-02

C_2 = +6.35669E-04

C_3 = -6.98786E-07

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.160217E-02

d.f. = 27

t_α = 2.05

α = 0.05

Temperature (°K)	Δk (W/cm-°K)	$S_{\overline{\Delta k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	-5.05009E-02	4.68155E-03	-7.61486E-02	-2.48531E-02	-6.00980E-02	-4.09037E-02
90.	-4.53321E-02	3.95481E-03	-7.04603E-02	-2.07039E-02	-5.34395E-02	-3.72247E-02
100.	-4.03032E-02	3.36139E-03	-6.50657E-02	-1.55406E-02	-4.71940E-02	-3.34123E-02
110.	-3.54139E-02	2.92143E-03	-5.99408E-02	-1.08879E-02	-4.14028E-02	-2.94250E-02
120.	-3.06644E-02	2.65003E-03	-5.50614E-02	-6.26747E-03	-3.60970E-02	-2.52319E-02
130.	-2.60547E-02	2.54352E-03	-5.04040E-02	-1.70541E-03	-3.12689E-02	-2.08405E-02
140.	-2.15847E-02	2.57175E-03	-4.59464E-02	2.77705E-03	-2.68568E-02	-1.63126E-02
150.	-1.72545E-02	2.68827E-03	-4.16691E-02	7.16003E-03	-2.27655E-02	-1.17436E-02
160.	-1.30640E-02	2.84795E-03	-3.75546E-02	1.14265E-02	-1.89023E-02	-7.22574E-03
170.	-9.01337E-03	3.01674E-03	-3.35887E-02	1.55619E-02	-1.51977E-02	-2.82907E-03
180.	-5.10241E-03	3.17230E-03	-2.97599E-02	1.95551E-02	-1.16056E-02	1.40079E-03
190.	-1.33126E-03	3.30118E-03	-2.60597E-02	2.33972E-02	-8.09868E-03	5.43616E-03
200.	2.30019E-03	3.39625E-03	-2.24873E-02	2.70827E-02	-4.66212E-03	9.26250E-03
210.	5.79189E-03	3.45493E-03	-1.90247E-02	3.06085E-02	-1.29072E-03	1.28745E-02
220.	9.14376E-03	3.47832E-03	-1.56865E-02	3.39741E-02	2.01322E-03	1.62743E-02
230.	1.23559E-02	3.47099E-03	-1.24701E-02	3.71819E-02	5.24041E-03	1.94715E-02
240.	1.54283E-02	3.44136E-03	-9.28036E-03	4.02370E-02	8.37353E-03	2.24831E-02
250.	1.83610E-02	3.40270E-03	-6.42498E-03	4.31469E-02	1.13865E-02	2.53355E-02
260.	2.11539E-02	3.37146E-03	-3.61441E-03	4.59227E-02	1.42424E-02	2.80654E-02
270.	2.38070E-02	3.37238E-03	-9.61848E-04	4.85758E-02	1.68936E-02	3.07204E-02
280.	2.63204E-02	3.43236E-03	1.51495E-03	5.11238E-02	1.92840E-02	3.33567E-02
290.	2.86939E-02	3.57910E-03	3.80351E-03	5.35844E-02	2.13568E-02	3.60311E-02
300.	3.09273E-02	3.83538E-03	5.87751E-03	5.59782E-02	2.30653E-02	3.87904E-02
310.	3.30219E-02	4.21488E-03	7.71663E-03	5.83272E-02	2.43814E-02	4.16624E-02
320.	3.49763E-02	4.72123E-03	9.29804E-03	6.06546E-02	2.52978E-02	4.46548E-02
330.	3.67909E-02	5.35080E-03	1.05989E-02	6.29829E-02	2.58218E-02	4.77600E-02
340.	3.84657E-02	6.09659E-03	1.15975E-02	6.53338E-02	2.59677E-02	5.09637E-02
350.	4.00008E-02	6.95071E-03	1.22748E-02	6.77268E-02	2.57518E-02	5.42498E-02
360.	4.13961E-02	7.99608E-03	1.26145E-02	7.01777E-02	2.51886E-02	5.76035E-02

Table F-5

THERMAL CONDUCTIVITY OF ALUMINUM: PREIRRADIATION RUNS 1 THRU 10

Input Data		Calculated Data		Run No.
Temperature (^oK)	Thermal Cond ($W/cm\text{-}^oK$)	Thermal Cond ($W/cm\text{-}^oK$)	Residuals (input-calc)	
8.117999D 01	8.678000E-01	8.667538E-01	1.046181E-03	1
8.556999D 01	8.927000E-01	8.891782E-01	3.521800E-03	2
8.940999D 01	9.020000E-01	9.085651E-01	-6.565154E-03	1
9.496999D 01	9.328000E-01	9.362584E-01	-3.458440E-03	3
9.735999D 01	9.339000E-01	9.480256E-01	-1.412559E-02	1
1.009000D 02	9.612000E-01	9.653025E-01	-4.102528E-03	4
1.022000D 02	9.658000E-01	9.716027E-01	-5.802691E-03	2
1.177000D 02	1.023000E 00	1.044831E 00	-2.183151E-02	2
1.217600D 02	1.066999E 00	1.063440E 00	3.559113E-03	5
1.275000D 02	1.098000E 00	1.089343E 00	8.656502E-03	3
1.332400D 02	1.132999E 00	1.114770E 00	1.822948E-02	6
1.356100D 02	1.143999E 00	1.125130E 00	1.886940E-02	7
1.400700D 02	1.165999E 00	1.144405E 00	2.159405E-02	8
1.427000D 02	1.151999E 00	1.155638E 00	-3.638268E-03	4
1.477300D 02	1.209999E 00	1.176843E 00	3.315639E-02	9
1.549100D 02	1.249000E 00	1.206477E 00	4.252243E-02	10
1.568000D 02	1.160000E 00	1.214155E 00	-5.415535E-02	3
1.799000D 02	1.231999E 00	1.303821E 00	-7.182121E-02	4
1.936800D 02	1.346999E 00	1.353642E 00	-6.642342E-03	5
2.203900D 02	1.459000E 00	1.442408E 00	1.659203E-02	6
2.257800D 02	1.478999E 00	1.459072E 00	1.992702E-02	7
2.359300D 02	1.521000E 00	1.489315E 00	3.168488E-02	8
2.526700D 02	1.594000E 00	1.535943E 00	5.805683E-02	9
2.554800D 02	1.487000E 00	1.543375E 00	-5.637550E-02	5
2.686399D 02	1.648999E 00	1.576658E 00	7.234097E-02	10
2.947400D 02	1.575000E 00	1.635275E 00	-6.027508E-02	6
3.027100D 02	1.598000E 00	1.651215E 00	-5.321503E-02	7
3.177200D 02	1.641999E 00	1.678745E 00	-3.674603E-02	8
3.423398D 02	1.719000E 00	1.716862E 00	2.138138E-03	9
3.658599D 02	1.792000E 00	1.745104E 00	4.689598E-02	10

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = 4.01953E-01

C_2 = 6.31139E-03

C_3 = -7.21633E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.680314E-02

d.f. = 27

t_α = 2.05

α = 0.05

Temperature (^oK)	k ($W/cm\text{-}^oK$)	$s_{\overline{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	8.60679E-01	1.48234E-02	7.79343E-01	9.42015E-01	8.30291E-01	8.91067E-01
90.	9.11525E-01	1.25595E-02	8.31806E-01	9.91244E-01	8.85778E-01	9.37272E-01
100.	9.60927E-01	1.07032E-02	8.82355E-01	1.03950E 00	9.38986E-01	9.82869E-01
110.	1.00889E 00	9.31595E-03	9.31060E-01	1.08671E 00	9.89789E-01	1.02798E 00
120.	1.05540E 00	8.44562E-03	9.77996E-01	1.13281E 00	1.03809E 00	1.07272E 00
130.	1.10048E 00	8.08578E-03	1.02323E 00	1.17772E 00	1.08390E 00	1.11705E 00
140.	1.14411E 00	8.15053E-03	1.06683E 00	1.22138E 00	1.12740E 00	1.16081E 00
150.	1.18629E 00	8.50123E-03	1.10886E 00	1.26373E 00	1.16886E 00	1.20372E 00
160.	1.22704E 00	8.99903E-03	1.14937E 00	1.30470E 00	1.20859E 00	1.24548E 00
170.	1.26633E 00	9.53659E-03	1.18840E 00	1.34427E 00	1.24678E 00	1.28588E 00
180.	1.30419E 00	1.00417E-02	1.22599E 00	1.38240E 00	1.28361E 00	1.32478E 00
190.	1.34060E 00	1.04702E-02	1.26216E 00	1.41904E 00	1.31914E 00	1.36207E 00
200.	1.37558E 00	1.07971E-02	1.29695E 00	1.45420E 00	1.35344E 00	1.39771E 00
210.	1.40910E 00	1.10119E-02	1.33035E 00	1.48785E 00	1.38653E 00	1.43167E 00
220.	1.44119E 00	1.11144E-02	1.36237E 00	1.52000E 00	1.41840E 00	1.46397E 00
230.	1.47183E 00	1.11151E-02	1.39301E 00	1.55064E 00	1.44904E 00	1.49461E 00
240.	1.50102E 00	1.10340E-02	1.42226E 00	1.57979E 00	1.47840E 00	1.52364E 00
250.	1.52878E 00	1.09041E-02	1.45009E 00	1.60746E 00	1.50642E 00	1.55113E 00
260.	1.55509E 00	1.07716E-02	1.47647E 00	1.63370E 00	1.53300E 00	1.57717E 00
270.	1.57996E 00	1.06995E-02	1.50138E 00	1.65852E 00	1.55802E 00	1.60189E 00
280.	1.60338E 00	1.07651E-02	1.52477E 00	1.68199E 00	1.58131E 00	1.62545E 00
290.	1.62536E 00	1.10537E-02	1.54658E 00	1.70413E 00	1.60270E 00	1.64802E 00
300.	1.64590E 00	1.16444E-02	1.56676E 00	1.72503E 00	1.62203E 00	1.66977E 00
310.	1.66499E 00	1.25951E-02	1.58525E 00	1.74473E 00	1.63917E 00	1.69081E 00
320.	1.68264E 00	1.39332E-02	1.60197E 00	1.76331E 00	1.65408E 00	1.71121E 00
330.	1.69885E 00	1.56588E-02	1.61686E 00	1.78084E 00	1.66675E 00	1.73095E 00
340.	1.71361E 00	1.77550E-02	1.62985E 00	1.79738E 00	1.67722E 00	1.75001E 00
350.	1.72694E 00	2.01982E-02	1.64087E 00	1.81300E 00	1.68553E 00	1.76834E 00
360.	1.73881E 00	2.29647E-02	1.64988E 00	1.82774E 00	1.69174E 00	1.78589E 00

Table F-6

THERMAL CONDUCTIVITY OF ALUMINUM: POSTIRRADIATION RUNS 1 THRU 10

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.129999D 01	8.260000E-01	8.188343E-01	7.165670E-03	1
8.529999D 01	8.444000E-01	8.411406E-01	3.259361E-03	2
8.939999D 01	8.620999E-01	8.637543E-01	-1.654327E-03	1
9.439999D 01	8.807999E-01	8.909888E-01	-1.018888E-02	3
9.689999D 01	8.953000E-01	9.044648E-01	-9.164810E-03	1
1.016000D 02	9.176000E-01	9.295443E-01	-1.194429E-02	2
1.027000D 02	9.216000E-01	9.353659E-01	-1.376593E-02	4
1.167000D 02	9.744999E-01	1.007865E 00	-3.336501E-02	2
1.211700D 02	1.033999E 00	1.030391E 00	3.608704E-03	5
1.250000D 02	1.030999E 00	1.049451E 00	-1.845169E-02	3
1.320900D 02	1.110999E 00	1.084152E 00	2.684689E-02	6
1.342600D 02	1.125000E 00	1.094622E 00	3.037834E-02	7
1.383100D 02	1.153999E 00	1.113972E 00	4.002762E-02	8
1.443000D 02	1.125999E 00	1.142137E 00	-1.613712E-02	4
1.460600D 02	1.205000E 00	1.150309E 00	5.469131E-02	9
1.524000D 02	1.113000E 00	1.179362E 00	-6.636238E-02	3
1.536700D 02	1.257000E 00	1.185110E 00	7.188988E-02	10
1.806000D 02	1.231999E 00	1.301247E 00	-6.924725E-02	4
1.907000D 02	1.325000E 00	1.341984E 00	-1.698399E-02	5
2.170500D 02	1.448000E 00	1.441023E 00	6.977081E-03	6
2.222000D 02	1.474000E 00	1.459157E 00	1.484299E-02	7
2.313100D 02	1.518999E 00	1.490255E 00	2.874374E-02	8
2.489800D 02	1.599999E 00	1.547007E 00	5.299282E-02	9
2.492700D 02	1.497000E 00	1.547899E 00	-5.089951E-02	5
2.660000D 02	1.676000E 00	1.597220E 00	7.877922E-02	10
2.881699D 02	1.596999E 00	1.656076E 00	-5.907726E-02	6
2.958799D 02	1.625999E 00	1.674808E 00	-4.880810E-02	7
3.094199D 02	1.667000E 00	1.705535E 00	-3.853512E-02	8
3.357200D 02	1.759000E 00	1.757319E 00	1.680374E-03	9
3.610000D 02	1.839999E 00	1.797266E 00	4.273319E-02	10

Least Squares Fit Coefficients

$k = C_1 + C_2 T + C_3 T^2$

$C_1 = 3.13178E-01$

$C_2 = 6.83253E-03$

$C_3 = -7.53874E-06$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 4.086613E-02$

d.f. = 27

$t_\alpha = 2.05$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\overline{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	8.11533E-01	1.64707E-02	7.21209E-01	9.01857E-01	7.77768E-01	8.45298E-01
90.	8.67042E-01	1.39114E-02	7.78546E-01	9.55539E-01	8.38524E-01	8.95561E-01
100.	9.21044E-01	1.18229E-02	8.33833E-01	1.00826E 00	8.96807E-01	9.45281E-01
110.	9.73538E-01	1.02768E-02	8.87154E-01	1.05992E 00	9.52470E-01	9.94605E-01
120.	1.02452E 00	9.32655E-03	9.38593E-01	1.11045E 00	1.00540E 00	1.04364E 00
130.	1.07400E 00	8.95853E-03	9.88237E-01	1.15977E 00	1.05564E 00	1.09237E 00
140.	1.12197E 00	9.06534E-03	1.03616E 00	1.20778E 00	1.10339E 00	1.14056E 00
150.	1.16844E 00	9.48235E-03	1.08243E 00	1.25444E 00	1.14900E 00	1.18787E 00
160.	1.21339E 00	1.00503E-02	1.12712E 00	1.29966E 00	1.19279E 00	1.23399E 00
170.	1.25684E 00	1.06492E-02	1.17027E 00	1.34341E 00	1.23501E 00	1.27867E 00
180.	1.29878E 00	1.12005E-02	1.21191E 00	1.38564E 00	1.27582E 00	1.32174E 00
190.	1.33921E 00	1.16570E-02	1.25209E 00	1.42633E 00	1.31531E 00	1.36311E 00
200.	1.37813E 00	1.19938E-02	1.29082E 00	1.46544E 00	1.35355E 00	1.40272E 00
210.	1.41555E 00	1.22015E-02	1.32812E 00	1.50298E 00	1.39054E 00	1.44056E 00
220.	1.45146E 00	1.22839E-02	1.36398E 00	1.53894E 00	1.42628E 00	1.47664E 00
230.	1.48586E 00	1.22570E-02	1.39840E 00	1.57332E 00	1.46073E 00	1.51099E 00
240.	1.51875E 00	1.21499E-02	1.43135E 00	1.60615E 00	1.49385E 00	1.54366E 00
250.	1.55014E 00	1.20073E-02	1.46282E 00	1.63746E 00	1.52552E 00	1.57475E 00
260.	1.58002E 00	1.18919E-02	1.49277E 00	1.66727E 00	1.55564E 00	1.60439E 00
270.	1.60839E 00	1.18854E-02	1.52114E 00	1.69563E 00	1.58402E 00	1.63275E 00
280.	1.63525E 00	1.20840E-02	1.54789E 00	1.72261E 00	1.61048E 00	1.66002E 00
290.	1.66060E 00	1.25861E-02	1.57294E 00	1.74826E 00	1.63480E 00	1.68640E 00
300.	1.68445E 00	1.34732E-02	1.59624E 00	1.77266E 00	1.65683E 00	1.71207E 00
310.	1.70679E 00	1.47946E-02	1.61769E 00	1.79589E 00	1.67646E 00	1.73712E 00
320.	1.72762E 00	1.65641E-02	1.63723E 00	1.81802E 00	1.69366E 00	1.76158E 00
330.	1.74694E 00	1.87694E-02	1.65475E 00	1.83913E 00	1.70847E 00	1.78542E 00
340.	1.76476E 00	2.13854E-02	1.67021E 00	1.85931E 00	1.72092E 00	1.80860E 00
350.	1.78107E 00	2.43845E-02	1.68351E 00	1.87862E 00	1.73108E 00	1.83106E 00
360.	1.79587E 00	2.77410E-02	1.69461E 00	1.89712E 00	1.73900E 00	1.85274E 00

Table F-7

THERMAL CONDUCTIVITY OF ALUMINUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 10

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.128000D 01	8.751000E-01	8.717831E-01	3.316820E-03	1
8.578000D 01	8.925000E-01	8.946682E-01	-2.168238E-03	2
8.942000D 01	9.141999E-01	9.129700E-01	1.229942E-03	1
9.500999D 01	9.327000E-01	9.407111E-01	-8.011162E-03	3
9.723000D 01	9.513000E-01	9.516058E-01	-3.058314E-04	1
1.009000D 02	9.608999E-01	9.694629E-01	-8.562982E-03	4
1.024000D 02	9.700000E-01	9.767067E-01	-6.706774E-03	2
1.178000D 02	1.030999E 00	1.049233E 00	-1.823425E-02	2
1.219200D 02	1.068000E 00	1.068068E 00	-6.771088E-05	5
1.276000D 02	1.091000E 00	1.093640E 00	-2.640724E-03	3
1.331900D 02	1.132000E 00	1.118361E 00	1.363850E-02	6
1.357700D 02	1.148000E 00	1.129622E 00	1.837730E-02	7
1.404000D 02	1.172999E 00	1.149594E 00	2.340508E-02	8
1.425000D 02	1.153999E 00	1.158553E 00	-4.553795E-03	4
1.475700D 02	1.212000E 00	1.179924E 00	3.207588E-02	9
1.548500D 02	1.250999E 00	1.209975E 00	4.102421E-02	10
1.567000D 02	1.169000E 00	1.217493E 00	-4.849339E-02	3
1.795000D 02	1.238999E 00	1.306159E 00	-6.715965E-02	4
1.936400D 02	1.349999E 00	1.357453E 00	-7.453918E-03	5
2.199600D 02	1.459000E 00	1.445395E 00	1.360416E-02	6
2.256600D 02	1.483999E 00	1.463149E 00	2.085018E-02	7
2.359200D 02	1.526999E 00	1.493949E 00	3.305054E-02	8
2.519100D 02	1.596000E 00	1.538979E 00	5.702114E-02	9
2.551700D 02	1.492999E 00	1.547714E 00	-5.471516E-02	5
2.682000D 02	1.653000E 00	1.581132E 00	7.186794E-02	10
2.938599D 02	1.579000E 00	1.639917E 00	-6.091785E-02	6
3.022200D 02	1.605000E 00	1.657057E 00	-5.205727E-02	7
3.173899D 02	1.650999E 00	1.685635E 00	-3.463554E-02	8
3.409600D 02	1.726999E 00	1.723574E 00	3.425598E-03	9
3.650000D 02	1.797999E 00	1.754173E 00	4.382610E-02	10

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = 4.09100E-01

C_2 = 6.26752E-03

C_3 = -7.07503E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.545276E-02

d.f. = 27

t_α = 2.05

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\overline{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	8.65221E-01	1.43159E-02	7.86842E-01	9.43601E-01	8.35874E-01	8.94569E-01
90.	9.15869E-01	1.21222E-02	8.39060E-01	9.92678E-01	8.91018E-01	9.40719E-01
100.	9.65101E-01	1.03236E-02	8.89405E-01	1.04080E 00	9.43938E-01	9.86265E-01
110.	1.01292E 00	8.97991E-03	9.37945E-01	1.08789E 00	9.94510E-01	1.03133E 00
120.	1.05932E 00	8.13769E-03	9.84752E-01	1.13389E 00	1.04264E 00	1.07600E 00
130.	1.10431E 00	7.79070E-03	1.02990E 00	1.17872E 00	1.08834E 00	1.12028E 00
140.	1.14788E 00	7.85511E-03	1.07344E 00	1.22232E 00	1.13178E 00	1.16398E 00
150.	1.19004E 00	8.19574E-03	1.11544E 00	1.26463E 00	1.17324E 00	1.20684E 00
160.	1.23078E 00	8.67767E-03	1.15596E 00	1.30560E 00	1.21299E 00	1.24857E 00
170.	1.27011E 00	9.19676E-03	1.19502E 00	1.34519E 00	1.25125E 00	1.28896E 00
180.	1.30802E 00	9.68336E-03	1.23268E 00	1.38336E 00	1.28817E 00	1.32787E 00
190.	1.34452E 00	1.00947E-02	1.26895E 00	1.42008E 00	1.32382E 00	1.36521E 00
200.	1.37960E 00	1.04072E-02	1.30385E 00	1.45535E 00	1.35827E 00	1.40094E 00
210.	1.41327E 00	1.06105E-02	1.33741E 00	1.48913E 00	1.39152E 00	1.43502E 00
220.	1.44552E 00	1.07051E-02	1.36960E 00	1.52144E 00	1.42358E 00	1.46747E 00
230.	1.47636E 00	1.07014E-02	1.40044E 00	1.55227E 00	1.45442E 00	1.49830E 00
240.	1.50578E 00	1.06196E-02	1.42991E 00	1.58165E 00	1.48401E 00	1.52755E 00
250.	1.53379E 00	1.04921E-02	1.45800E 00	1.60958E 00	1.51228E 00	1.55530E 00
260.	1.56038E 00	1.03651E-02	1.48466E 00	1.63610E 00	1.53913E 00	1.58163E 00
270.	1.58556E 00	1.03007E-02	1.50988E 00	1.66124E 00	1.56444E 00	1.60668E 00
280.	1.60932E 00	1.03750E-02	1.53360E 00	1.68505E 00	1.58805E 00	1.63059E 00
290.	1.63167E 00	1.06712E-02	1.55577E 00	1.70757E 00	1.60979E 00	1.65354E 00
300.	1.65260E 00	1.12657E-02	1.57634E 00	1.72886E 00	1.62951E 00	1.67570E 00
310.	1.67212E 00	1.22127E-02	1.59525E 00	1.74899E 00	1.64708E 00	1.69715E 00
320.	1.69022E 00	1.35369E-02	1.61243E 00	1.76802E 00	1.66247E 00	1.71797E 00
330.	1.70691E 00	1.52365E-02	1.62780E 00	1.78601E 00	1.67567E 00	1.73814E 00
340.	1.72218E 00	1.72941E-02	1.64132E 00	1.80305E 00	1.68673E 00	1.75763E 00
350.	1.73604E 00	1.96865E-02	1.65291E 00	1.81917E 00	1.69568E 00	1.77640E 00
360.	1.74848E 00	2.23907E-02	1.66252E 00	1.83444E 00	1.70258E 00	1.79438E 00

Table F-8

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: PREIRRADIATION RUNS 1 THRU 4

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
7.8969999D 01	2.134000E 00	2.149356E 00	-1.535606E-02	1
8.2969999D 01	2.207000E 00	2.208212E 00	-1.212120E-03	1
8.3920000D 01	2.216000E 00	2.221541E 00	-5.541801E-03	2
8.6840000D 01	2.287999E 00	2.260951E 00	2.704811E-02	1
9.0170000D 01	2.304000E 00	2.303022E 00	9.775162E-04	3
9.7189999D 01	2.341999E 00	2.381686E 00	-3.968716E-02	4
9.8799999D 01	2.408000E 00	2.397808E 00	1.019192E-02	2
1.1260000D 02	2.568999E 00	2.506661E 00	6.233788E-02	2
1.1770000D 02	2.521999E 00	2.533588E 00	-1.158905E-02	3
1.3910000D 02	2.540000E 00	2.568307E 00	-2.830696E-02	4
1.4380000D 02	2.551999E 00	2.559003E 00	-7.003784E-03	3
1.8180000D 02	2.268000E 00	2.259847E 00	8.152962E-03	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 8.31689E-02

C_2 = 3.70627E-02

C_3 = -1.38007E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.909106E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.16493E 00	1.46547E-02	2.09132E 00	2.23855E 00	2.13181E 00	2.19805E 00
90.	2.30095E 00	1.00827E-02	2.23137E 00	2.37053E 00	2.27816E 00	2.32373E 00
100.	2.40936E 00	9.90660E-03	2.33991E 00	2.47881E 00	2.38697E 00	2.43175E 00
110.	2.49017E 00	1.18872E-02	2.41915E 00	2.56119E 00	2.46331E 00	2.51704E 00
120.	2.54338E 00	1.37280E-02	2.47068E 00	2.61608E 00	2.51236E 00	2.57441E 00
130.	2.56899E 00	1.47354E-02	2.49529E 00	2.64269E 00	2.53569E 00	2.60229E 00
140.	2.56700E 00	1.50014E-02	2.49302E 00	2.64097E 00	2.53309E 00	2.60090E 00
150.	2.53740E 00	1.51697E-02	2.46325E 00	2.61155E 00	2.50312E 00	2.57168E 00
160.	2.48021E 00	1.64475E-02	2.40468E 00	2.55573E 00	2.44304E 00	2.51738E 00
170.	2.39541E 00	2.01141E-02	2.31548E 00	2.47534E 00	2.34995E 00	2.44087E 00
180.	2.28301E 00	2.66616E-02	2.19383E 00	2.37219E 00	2.22275E 00	2.34326E 00

Table F-9

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: POSTIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
7.895000D 01	1.146999E 00	1.169048E 00	-2.204895E-02	1
8.293999D 01	1.223000E 00	1.210626E 00	1.237392E-02	1
8.359000D 01	1.205000E 00	1.217243E 00	-1.224327E-02	2
8.668999D 01	1.299999E 00	1.248202E 00	5.179691E-02	1
9.023000D 01	1.263000E 00	1.282341E 00	-1.934147E-02	3
9.787000D 01	1.358999E 00	1.351605E 00	7.393837E-03	2
9.856000D 01	1.311999E 00	1.357565E 00	-4.556561E-02	4
1.107000D 02	1.507000E 00	1.454352E 00	5.264759E-02	2
1.176000D 02	1.490000E 00	1.502574E 00	-1.257420E-02	3
1.417000D 02	1.650000E 00	1.632401E 00	1.759911E-02	3
1.420000D 02	1.599000E 00	1.633637E 00	-3.463745E-02	4
1.814000D 02	1.719999E 00	1.715384E 00	4.614830E-03	4

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = +8.01070E-03

C_2 = +1.87855E-02

C_3 = -5.16720E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 3.405505E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.18015E 00	1.71244E-02	1.09400E 00	1.26630E 00	1.14145E 00	1.21885E 00
90.	1.28016E 00	1.17712E-02	1.19873E 00	1.36159E 00	1.25356E 00	1.30676E 00
100.	1.36984E 00	1.16498E-02	1.28850E 00	1.45118E 00	1.34351E 00	1.39617E 00
110.	1.44918E 00	1.40291E-02	1.36594E 00	1.53242E 00	1.41748E 00	1.48089E 00
120.	1.51819E 00	1.61971E-02	1.43297E 00	1.60342E 00	1.48159E 00	1.55480E 00
130.	1.57687E 00	1.73545E-02	1.49049E 00	1.66325E 00	1.53765E 00	1.61609E 00
140.	1.62521E 00	1.76246E-02	1.53855E 00	1.71187E 00	1.58538E 00	1.66504E 00
150.	1.66322E 00	1.77869E-02	1.57639E 00	1.75005E 00	1.62302E 00	1.70341E 00
160.	1.69089E 00	1.92994E-02	1.60242E 00	1.77935E 00	1.64727E 00	1.73450E 00
170.	1.70823E 00	2.36945E-02	1.61446E 00	1.80199E 00	1.65468E 00	1.76177E 00
180.	1.71523E 00	3.15294E-02	1.61034E 00	1.82011E 00	1.64397E 00	1.78648E 00

Table F-10

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
7.910999D 01	2.094999E 00	2.143853E 00	-4.885387E-02	1
8.314000D 01	2.205999E 00	2.207452E 00	-1.452446E-03	1
8.428000D 01	2.224999E 00	2.224571E 00	4.281998E-04	2
8.695000D 01	2.327000E 00	2.263156E 00	6.384373E-02	1
9.064999D 01	2.308000E 00	2.313139E 00	-5.139351E-03	3
9.750999D 01	2.370000E 00	2.395080E 00	-2.507973E-02	4
9.896999D 01	2.421000E 00	2.410721E 00	1.027870E-02	2
1.126000D 02	2.577000E 00	2.526282E 00	5.071735E-02	2
1.178000D 02	2.539000E 00	2.555872E 00	-1.687241E-02	3
1.380000D 02	2.558000E 00	2.594844E 00	-3.684425E-02	4
1.436000D 02	2.582999E 00	2.584254E 00	-1.255035E-03	3
1.792000D 02	2.309999E 00	2.299757E 00	1.024246E-02	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -7.85080E-02$

$C_2 = 3.98060E-02$

$C_3 = -1.48071E-04$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 3.581893E-02$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.15831E 00	1.83523E-02	2.06736E 00	2.24927E 00	2.11684E 00	2.19979E 00
90.	2.30465E 00	1.24775E-02	2.21893E 00	2.39037E 00	2.27645E 00	2.33285E 00
100.	2.42138E 00	1.22550E-02	2.33582E 00	2.50693E 00	2.39368E 00	2.44907E 00
110.	2.50849E 00	1.47358E-02	2.42095E 00	2.59602E 00	2.47518E 00	2.54179E 00
120.	2.56598E 00	1.69611E-02	2.47641E 00	2.65555E 00	2.52765E 00	2.60431E 00
130.	2.59386E 00	1.80915E-02	2.50317E 00	2.68455E 00	2.55297E 00	2.63475E 00
140.	2.59213E 00	1.83219E-02	2.50120E 00	2.68305E 00	2.55072E 00	2.63354E 00
150.	2.56078E 00	1.86250E-02	2.46954E 00	2.65202E 00	2.51869E 00	2.60287E 00
160.	2.49982E 00	2.07179E-02	2.40630E 00	2.59334E 00	2.45300E 00	2.54664E 00
170.	2.40924E 00	2.61779E-02	2.30898E 00	2.50951E 00	2.35008E 00	2.46840E 00
180.	2.28905E 00	3.53839E-02	2.17526E 00	2.40284E 00	2.20908E 00	2.36902E 00

Table F-11

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
7.900000D 01	-9.844000E-01	-9.900245E-01	5.624533E-03	1
8.300000D 01	-9.832000E-01	-9.988203E-01	1.562035E-02	1
8.300000D 01	-9.972000E-01	-9.988203E-01	1.620352E-03	2
8.600000D 01	-9.840000E-01	-1.004210E 00	2.020955E-02	1
9.000000D 01	-1.036300E 00	-1.009784E 00	-2.651596E-02	3
9.800000D 01	-1.033000E 00	-1.015411E 00	-1.758862E-02	2
9.800000D 01	-1.036699E 00	-1.015411E 00	-2.128792E-02	4
1.030000D 02	-9.421000E-01	-1.015190E 00	7.309014E-02	5
1.110000D 02	-1.044700E 00	-1.008854E 00	-3.584576E-02	2
1.180000D 02	-1.030499E 00	-9.972697E-01	-3.322971E-02	3
1.400000D 02	-9.464000E-01	-9.241647E-01	-2.223533E-02	4
1.420000D 02	-9.099000E-01	-9.147581E-01	4.858196E-03	3
1.570000D 02	-8.298000E-01	-8.295383E-01	-2.616048E-04	5
1.800000D 02	-5.738000E-01	-6.485946E-01	7.479465E-02	4
2.070000D 02	-3.974000E-01	-3.585305E-01	-3.886944E-02	5

Least Squares Fit Coefficients

$$\Delta k = C_1 + C_2 T + C_3 T^2$$

C_1 = -4.39142E-01

C_2 = -1.15173E-02

C_3 = +5.75206E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.819550E-02

d.f. = 12

t_α = 2.18

α = 0.05

Temperature (°K)	Δk (W/cm-°K)	$S_{\overline{\Delta k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	-9.92396E-01	1.77230E-02	-1.08419E 00	-9.00603E-01	-1.03103E 00	-9.53760E-01
90.	-1.00978E 00	1.27590E-02	-1.09757E 00	-9.21996E-01	-1.03760E 00	-9.81970E-01
100.	-1.01567E 00	1.13461E-02	-1.10253E 00	-9.28807E-01	-1.04040E 00	-9.90934E-01
110.	-1.01005E 00	1.25977E-02	-1.09773E 00	-9.22371E-01	-1.03751E 00	-9.82586E-01
120.	-9.92925E-01	1.45668E-02	-1.08204E 00	-9.03809E-01	-1.02468E 00	-9.61169E-01
130.	-9.64297E-01	1.61679E-02	-1.05472E 00	-8.73878E-01	-9.99543E-01	-9.29051E-01
140.	-9.24165E-01	1.70655E-02	-1.01536E 00	-8.32966E-01	-9.61368E-01	-8.86962E-01
150.	-8.72529E-01	1.73003E-02	-9.63938E-01	-7.81120E-01	-9.10244E-01	-8.34814E-01
160.	-8.09388E-01	1.72023E-02	-9.00709E-01	-7.18067E-01	-8.46889E-01	-7.71887E-01
170.	-7.34744E-01	1.74378E-02	-8.26277E-01	-6.43211E-01	-7.72758E-01	-6.96730E-01
180.	-6.48595E-01	1.89618E-02	-7.41557E-01	-5.55633E-01	-6.89932E-01	-6.07258E-01
190.	-5.50942E-01	2.25991E-02	-6.47692E-01	-4.54193E-01	-6.00208E-01	-5.01676E-01
200.	-4.41786E-01	2.86139E-02	-5.45826E-01	-3.37746E-01	-5.04164E-01	-3.79408E-01
210.	-3.21124E-01	3.68439E-02	-4.36815E-01	-2.05433E-01	-4.01444E-01	-2.40804E-01

Table F-12

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: PREIRRADIATION RUNS 1 THRU 6

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
7.896999D 01	2.134000E 00	2.167062E 00	-3.306198E-02	1
8.296999D 01	2.207000E 00	2.213241E 00	-6.240845E-03	1
8.392000D 01	2.216000E 00	2.223733E 00	-7.733345E-03	2
8.684000D 01	2.287999E 00	2.254843E 00	3.315639E-02	1
9.017000D 01	2.304000E 00	2.288219E 00	1.578045E-02	3
9.718999D 01	2.341999E 00	2.351246E 00	-9.246826E-03	4
9.879999D 01	2.408000E 00	2.364297E 00	4.370308E-02	2
1.000200D 02	2.308000E 00	2.373839E 00	-6.583977E-02	5
1.029700D 02	2.302999E 00	2.395669E 00	-9.266949E-02	6
1.126000D 02	2.568999E 00	2.454702E 00	1.142969E-01	2
1.177000D 02	2.521999E 00	2.478381E 00	4.361820E-02	3
1.391000D 02	2.540000E 00	2.520487E 00	1.951313E-02	4
1.438000D 02	2.551999E 00	2.517349E 00	3.464985E-02	3
1.482100D 02	2.483000E 00	2.510349E 00	-2.734947E-02	5
1.577500D 02	2.462000E 00	2.481771E 00	-1.977158E-02	6
1.818000D 02	2.268000E 00	2.328168E 00	-6.016827E-02	4
1.988200D 02	2.103999E 00	2.148893E 00	-4.489422E-02	5
2.171300D 02	1.952999E 00	1.890720E 00	6.227875E-02	6

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 5.93896E-01$

$C_2 = 2.78938E-02$

$C_3 = -1.00959E-04$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 5.456442E-02$

d.f. = 15

$t_\alpha = 2.13$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.17926E 00	2.44389E-02	2.05191E 00	2.30661E 00	2.12721E 00	2.23132E 00
90.	2.28657E 00	1.77955E-02	2.16432E 00	2.40882E 00	2.24866E 00	2.32447E 00
100.	2.37369E 00	1.50773E-02	2.25311E 00	2.49426E 00	2.34157E 00	2.40580E 00
110.	2.44061E 00	1.58387E-02	2.31959E 00	2.56163E 00	2.40687E 00	2.47435E 00
120.	2.48734E 00	1.80448E-02	2.36493E 00	2.60975E 00	2.44891E 00	2.52578E 00
130.	2.51388E 00	2.01624E-02	2.38998E 00	2.63778E 00	2.47094E 00	2.55683E 00
140.	2.52023E 00	2.15678E-02	2.39526E 00	2.64520E 00	2.47429E 00	2.56617E 00
150.	2.50639E 00	2.21304E-02	2.38097E 00	2.63181E 00	2.45925E 00	2.55353E 00
160.	2.47235E 00	2.20258E-02	2.34702E 00	2.59769E 00	2.42544E 00	2.51927E 00
170.	2.41813E 00	2.17440E-02	2.29302E 00	2.54324E 00	2.37181E 00	2.46444E 00
180.	2.34371E 00	2.21558E-02	2.21827E 00	2.46915E 00	2.29652E 00	2.39090E 00
190.	2.24910E 00	2.43754E-02	2.12181E 00	2.37639E 00	2.19718E 00	2.30102E 00
200.	2.13430E 00	2.92234E-02	2.00245E 00	2.26614E 00	2.07205E 00	2.19654E 00
210.	1.99930E 00	3.68570E-02	1.85905E 00	2.13955E 00	1.92080E 00	2.07781E 00
220.	1.84412E 00	4.70333E-02	1.69068E 00	1.99756E 00	1.74393E 00	1.94430E 00

Table F-13

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: POSTIRRADIATION RUNS 1 THRU 5

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
7.895000D 01	1.146999E 00	1.172605E 00	-2.560520E-02	1
8.293999D 01	1.223000E 00	1.212365E 00	1.063442E-02	1
8.359000D 01	1.205000E 00	1.218698E 00	-1.369762E-02	2
8.668999D 01	1.299999E 00	1.248342E 00	5.165768E-02	1
9.023000D 01	1.263000E 00	1.281065E 00	-1.806545E-02	3
9.787000D 01	1.358999E 00	1.347589E 00	1.141071E-02	2
9.856000D 01	1.311999E 00	1.353320E 00	-4.137080E-02	4
1.035000D 02	1.377999E 00	1.393026E 00	-1.502705E-02	5
1.107000D 02	1.507000E 00	1.446700E 00	6.029987E-02	2
1.176000D 02	1.490000E 00	1.493470E 00	-3.470421E-03	3
1.417000D 02	1.650000E 00	1.620975E 00	2.902508E-02	3
1.420000D 02	1.599000E 00	1.622211E 00	-2.321053E-02	4
1.577000D 02	1.638000E 00	1.674836E 00	-3.683662E-02	5
1.814000D 02	1.719999E 00	1.709466E 00	1.053333E-02	4
2.070000D 02	1.690000E 00	1.686310E 00	3.689765E-03	5

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = +7.163447E-02$

$C_2 = +1.773378E-02$

$C_3 = -4.798752E-05$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 3.230766E-02$

d.f. = 12

$t_\alpha = 2.18$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.18322E 00	1.51403E-02	1.10543E 00	1.26100E 00	1.15021E 00	1.21622E 00
90.	1.27897E 00	1.08557E-02	1.20467E 00	1.35327E 00	1.25531E 00	1.30264E 00
100.	1.36514E 00	9.60888E-03	1.29165E 00	1.43862E 00	1.34419E 00	1.38608E 00
110.	1.44170E 00	1.06704E-02	1.36753E 00	1.51587E 00	1.41844E 00	1.46496E 00
120.	1.50867E 00	1.23609E-02	1.43326E 00	1.58408E 00	1.48172E 00	1.53561E 00
130.	1.56604E 00	1.37378E-02	1.48950E 00	1.64257E 00	1.53609E 00	1.59598E 00
140.	1.61381E 00	1.45068E-02	1.53640E 00	1.69101E 00	1.58218E 00	1.64543E 00
150.	1.65198E 00	1.46954E-02	1.57461E 00	1.72936E 00	1.61995E 00	1.68402E 00
160.	1.68056E 00	1.45760E-02	1.60329E 00	1.75783E 00	1.64878E 00	1.71233E 00
170.	1.69954E 00	1.47085E-02	1.62215E 00	1.77692E 00	1.66747E 00	1.73160E 00
180.	1.70892E 00	1.59126E-02	1.63041E 00	1.78743E 00	1.67423E 00	1.74361E 00
190.	1.70870E 00	1.89186E-02	1.62709E 00	1.79032E 00	1.66746E 00	1.74995E 00
200.	1.69889E 00	2.39676E-02	1.61119E 00	1.78658E 00	1.64664E 00	1.75114E 00
210.	1.67948E 00	3.09200E-02	1.58199E 00	1.77697E 00	1.61207E 00	1.74688E 00

Table F-14

THERMAL CONDUCTIVITY OF NBS BERYLLIUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 5

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
7.910999D 01	2.094999E 00	2.172631E 00	-7.763195E-02	1
8.314000D 01	2.205999E 00	2.221587E 00	-1.558781E-02	1
8.428000D 01	2.224999E 00	2.234832E 00	-9.832382E-03	2
8.695000D 01	2.327000E 00	2.264810E 00	6.219006E-02	1
9.064999D 01	2.308000E 00	2.303936E 00	4.063606E-03	3
9.750999D 01	2.370000E 00	2.369057E 00	9.431839E-04	4
9.896999D 01	2.421000E 00	2.381672E 00	3.932762E-02	2
1.043000D 02	2.339999E 00	2.424016E 00	-8.401680E-02	5
1.126000D 02	2.577000E 00	2.478363E 00	9.863663E-02	2
1.178000D 02	2.539000E 00	2.505218E 00	3.378201E-02	3
1.380000D 02	2.558000E 00	2.556962E 00	1.037598E-03	4
1.436000D 02	2.582999E 00	2.556502E 00	2.649689E-02	3
1.593300D 02	2.488999E 00	2.520829E 00	-3.182983E-02	5
1.792000D 02	2.309999E 00	2.403281E 00	-9.328175E-02	4
2.192600D 02	1.966000E 00	1.920280E 00	4.571915E-02	5

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 5.37639E-01

C_2 = 2.87739E-02

C_3 = -1.02472E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.932627E-02

d.f. = 12

t_α = 2.18

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.18373E 00	2.74779E-02	2.04120E 00	2.32626E 00	2.12383E 00	2.24363E 00
90.	2.29727E 00	2.01165E-02	2.16070E 00	2.43383E 00	2.25341E 00	2.34112E 00
100.	2.39031E 00	1.73329E-02	2.25557E 00	2.52505E 00	2.35252E 00	2.42809E 00
110.	2.46286E 00	1.85078E-02	2.32738E 00	2.59834E 00	2.42251E 00	2.50320E 00
120.	2.51491E 00	2.12724E-02	2.37752E 00	2.65230E 00	2.46854E 00	2.56129E 00
130.	2.54647E 00	2.39390E-02	2.40701E 00	2.68593E 00	2.49428E 00	2.59866E 00
140.	2.55754E 00	2.58494E-02	2.41646E 00	2.69861E 00	2.50118E 00	2.61389E 00
150.	2.54811E 00	2.68894E-02	2.40611E 00	2.69010E 00	2.48949E 00	2.60673E 00
160.	2.51818E 00	2.72795E-02	2.37584E 00	2.66053E 00	2.45872E 00	2.57765E 00
170.	2.46777E 00	2.75544E-02	2.32517E 00	2.61037E 00	2.40770E 00	2.52783E 00
180.	2.39685E 00	2.85871E-02	2.25329E 00	2.54042E 00	2.33453E 00	2.45917E 00
190.	2.30545E 00	3.14364E-02	2.15908E 00	2.45181E 00	2.23692E 00	2.37398E 00
200.	2.19355E 00	3.69303E-02	2.04121E 00	2.34589E 00	2.11304E 00	2.27406E 00
210.	2.06115E 00	4.53505E-02	1.89836E 00	2.22394E 00	1.96229E 00	2.16002E 00
220.	1.90827E 00	5.65738E-02	1.72956E 00	2.08697E 00	1.78493E 00	2.03160E 00

Table F-15

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: PREIRRADIATION RUNS 1 THRU 3

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.035999D 01	2.962000E 00	2.982348E 00	-2.034855E-02	1
8.406000D 01	3.039000E 00	3.054800E 00	-1.580048E-02	2
8.818999D 01	3.157000E 00	3.126938E 00	3.006172E-02	1
9.145000D 01	3.118999E 00	3.177373E 00	-5.837345E-02	3
9.557999D 01	3.335999E 00	3.233027E 00	1.029730E-01	1
9.973999D 01	3.257000E 00	3.279771E 00	-2.277088E-02	2
1.145000D 02	3.415000E 00	3.370204E 00	4.479599E-02	2
1.235000D 02	3.294000E 00	3.367599E 00	-7.359886E-02	3
1.561000D 02	3.004999E 00	2.991920E 00	1.307869E-02	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -4.15456E-01$

$C_2 = 6.39841E-02$

$C_3 = -2.70057E-04$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 6.283754E-02$

d.f. = 6

$t_\alpha = 2.45$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.97491E 00	4.11622E-02	2.79086E 00	3.15895E 00	2.87406E 00	3.07575E 00
90.	3.15565E 00	2.45229E-02	2.99039E 00	3.32091E 00	3.09557E 00	3.21573E 00
100.	3.28238E 00	2.67851E-02	3.11503E 00	3.44974E 00	3.21676E 00	3.34800E 00
110.	3.35510E 00	3.41109E-02	3.17993E 00	3.53027E 00	3.27153E 00	3.43867E 00
120.	3.37381E 00	3.81439E-02	3.19372E 00	3.55391E 00	3.28036E 00	3.46726E 00
130.	3.33851E 00	3.87522E-02	3.15764E 00	3.51938E 00	3.24357E 00	3.43345E 00
140.	3.24920E 00	4.01331E-02	3.06652E 00	3.43187E 00	3.15087E 00	3.34752E 00
150.	3.10587E 00	4.98054E-02	2.90943E 00	3.30232E 00	2.98385E 00	3.22789E 00
160.	2.90854E 00	7.21689E-02	2.67409E 00	3.14298E 00	2.73172E 00	3.08535E 00

Table F-16

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: POSTIRRADIATION RUNS 1 THRU 3

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.042000D 01	1.287000E 00	1.306529E 00	-1.952934E-02	1
8.423999D 01	1.342999E 00	1.366612E 00	-2.361298E-02	2
8.815999D 01	1.452000E 00	1.424660E 00	2.733994E-02	1
9.217000D 01	1.434999E 00	1.480259E 00	-4.525948E-02	3
9.507999D 01	1.608999E 00	1.518212E 00	9.078693E-02	1
1.003000D 02	1.561999E 00	1.581247E 00	-1.924801E-02	2
1.142000D 02	1.768000E 00	1.717497E 00	5.050278E-02	2
1.252000D 02	1.714999E 00	1.792752E 00	-7.775307E-02	3
1.542000D 02	1.870000E 00	1.853219E 00	1.678085E-02	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -7.63896E-01$

$C_2 = 3.53076E-02$

$C_3 = -1.18907E-04$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 5.947726E-02$

d.f. = 6

$t_\alpha = 2.45$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.29971E 00	3.95327E-02	1.12474E 00	1.47468E 00	1.20286E 00	1.39657E 00
90.	1.45065E 00	2.33269E-02	1.29412E 00	1.60717E 00	1.39349E 00	1.50780E 00
100.	1.57780E 00	2.56677E-02	1.41909E 00	1.73651E 00	1.51491E 00	1.64069E 00
110.	1.68117E 00	3.25180E-02	1.51510E 00	1.84725E 00	1.60150E 00	1.76084E 00
120.	1.76076E 00	3.59020E-02	1.59055E 00	1.93097E 00	1.67280E 00	1.84872E 00
130.	1.81657E 00	3.60607E-02	1.64616E 00	1.98698E 00	1.72822E 00	1.90492E 00
140.	1.84860E 00	3.79348E-02	1.67577E 00	2.02144E 00	1.75566E 00	1.94154E 00
150.	1.85685E 00	4.94977E-02	1.66727E 00	2.04643E 00	1.73558E 00	1.97812E 00
160.	1.84131E 00	7.40039E-02	1.60870E 00	2.07392E 00	1.66000E 00	2.02262E 00

Table F-17

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 3

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.042000D 01	2.995999E 00	3.007199E 00	-1.119995E-02	1
8.378000D 01	3.059999E 00	3.069655E 00	-9.655952E-03	2
8.818999D 01	3.160000E 00	3.142753E 00	1.724720E-02	1
9.103999D 01	3.153000E 00	3.184633E 00	-3.163338E-02	3
9.557999D 01	3.302999E 00	3.242655E 00	6.034470E-02	1
9.878000D 01	3.259999E 00	3.277136E 00	-1.713657E-02	2
1.130000D 02	3.400000E 00	3.366187E 00	3.381252E-02	2
1.220000D 02	3.318000E 00	3.368411E 00	-5.041122E-02	3
1.533000D 02	3.058000E 00	3.049380E 00	8.619308E-03	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -2.33067E-01$

$C_2 = 6.11250E-02$

$C_3 = -2.59054E-04$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 3.918081E-02$

d.f. = 6

$t_\alpha = 2.45$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.99898E 00	2.58048E-02	2.88404E 00	3.11392E 00	2.93576E 00	3.06220E 00
90.	3.16984E 00	1.51782E-02	3.06689E 00	3.27278E 00	3.13265E 00	3.20702E 00
100.	3.28889E 00	1.70090E-02	3.18424E 00	3.39353E 00	3.24721E 00	3.33056E 00
110.	3.35612E 00	2.16447E-02	3.24645E 00	3.46579E 00	3.30309E 00	3.40915E 00
120.	3.37154E 00	2.39238E-02	3.25907E 00	3.48402E 00	3.31293E 00	3.43016E 00
130.	3.33516E 00	2.41646E-02	3.22237E 00	3.44794E 00	3.27595E 00	3.39436E 00
140.	3.24696E 00	2.57880E-02	3.13204E 00	3.36188E 00	3.18378E 00	3.31014E 00
150.	3.10695E 00	3.39959E-02	2.97986E 00	3.23404E 00	3.02366E 00	3.19024E 00
160.	2.91513E 00	5.07454E-02	2.75806E 00	3.07220E 00	2.79081E 00	3.03946E 00

Table F-18

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.000000D 01	-1.674700E 00	-1.682192E 00	7.492065E-03	1
8.400000D 01	-1.698600E 00	-1.691571E 00	-7.028580E-03	2
8.800000D 01	-1.705899E 00	-1.697064E 00	-8.834839E-03	1
9.200000D 01	-1.690700E 00	-1.698674E 00	7.974625E-03	3
9.500000D 01	-1.715699E 00	-1.697332E 00	-1.836681E-02	1
9.700000D 01	-1.651999E 00	-1.695224E 00	4.322433E-02	4
1.000000D 02	-1.701699E 00	-1.690240E 00	-1.145935E-02	2
1.140000D 02	-1.643399E 00	-1.638090E 00	-5.309105E-03	2
1.240000D 02	-1.586399E 00	-1.571707E 00	-1.469231E-02	3
1.370000D 02	-1.483000E 00	-1.449110E 00	-3.388977E-02	4
1.540000D 02	-1.162499E 00	-1.226883E 00	6.438351E-02	3
1.750000D 02	-8.789999E-01	-8.554944E-01	-2.350551E-02	4

Least Squares Fit Coefficients

$$\Delta k = C_1 + C_2 T + C_3 T^2$$

C_1 = -6.78861E-01

C_2 = -2.22531E-02

C_3 = +1.21393E-04

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.104563E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	Δk (W/cm-°K)	$s_{\overline{\Delta k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	-1.68219E 00	1.81052E-02	-1.76341E 00	-1.60097E 00	-1.72311E 00	-1.64127E 00
90.	-1.69835E 00	1.15188E-02	-1.77319E 00	-1.62352E 00	-1.72439E 00	-1.67232E 00
100.	-1.69024E 00	1.07104E-02	-1.76446E 00	-1.61602E 00	-1.71445E 00	-1.66603E 00
110.	-1.65785E 00	1.30144E-02	-1.73392E 00	-1.58177E 00	-1.68726E 00	-1.62843E 00
120.	-1.60117E 00	1.50652E-02	-1.67916E 00	-1.52319E 00	-1.63522E 00	-1.56713E 00
130.	-1.52022E 00	1.58968E-02	-1.59905E 00	-1.44139E 00	-1.55615E 00	-1.48429E 00
140.	-1.41499E 00	1.57048E-02	-1.49362E 00	-1.33636E 00	-1.45048E 00	-1.37950E 00
150.	-1.28548E 00	1.56116E-02	-1.36402E 00	-1.20695E 00	-1.32077E 00	-1.25020E 00
160.	-1.13170E 00	1.77121E-02	-1.21247E 00	-1.05092E 00	-1.17173E 00	-1.09167E 00
170.	-9.53631E-01	2.36894E-02	-1.04189E 00	-8.65375E-01	-1.00717E 00	-9.00093E-01

Table F-19

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: PREIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.035999D 01	2.962000E 00	3.004338E 00	-4.233837E-02	1
8.406000D 01	3.039000E 00	3.061597E 00	-2.259731E-02	2
8.818999D 01	3.157000E 00	3.118993E 00	3.800678E-02	1
9.145000D 01	3.118999E 00	3.159444E 00	-4.044437E-02	3
9.504999D 01	3.115999E 00	3.199137E 00	-8.313751E-02	4
9.557999D 01	3.335999E 00	3.204539E 00	1.314602E-01	1
9.973999D 01	3.257000E 00	3.243013E 00	1.398659E-02	2
1.145000D 02	3.415000E 00	3.323244E 00	9.175587E-02	2
1.235000D 02	3.294000E 00	3.329074E 00	-3.507423E-02	3
1.361500D 02	3.259999E 00	3.282079E 00	-2.207947E-02	4
1.561000D 02	3.004999E 00	3.076902E 00	-7.190323E-02	3
1.804700D 02	2.650999E 00	2.608617E 00	4.238224E-02	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 3.99490E-01

C_2 = 4.86086E-02

C_3 = -2.01516E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 7.216936E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\overline{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.99847E 00	4.13058E-02	2.81054E 00	3.18640E 00	2.90512E 00	3.09182E 00
90.	3.14198E 00	2.66896E-02	2.96808E 00	3.31588E 00	3.08166E 00	3.20230E 00
100.	3.24519E 00	2.44436E-02	3.07298E 00	3.41739E 00	3.18994E 00	3.30043E 00
110.	3.30809E 00	2.95427E-02	3.13185E 00	3.48433E 00	3.24132E 00	3.37485E 00
120.	3.33069E 00	3.46420E-02	3.14977E 00	3.51161E 00	3.25240E 00	3.40898E 00
130.	3.31298E 00	3.73102E-02	3.12937E 00	3.49659E 00	3.22866E 00	3.39730E 00
140.	3.25498E 00	3.75757E-02	3.07109E 00	3.43886E 00	3.17005E 00	3.33990E 00
150.	3.15666E 00	3.70596E-02	2.97331E 00	3.34001E 00	3.07291E 00	3.24042E 00
160.	3.01805E 00	3.92580E-02	2.83238E 00	3.20372E 00	2.92933E 00	3.10677E 00
170.	2.83913E 00	4.82750E-02	2.64290E 00	3.03536E 00	2.73003E 00	2.94823E 00
180.	2.61991E 00	6.56276E-02	2.39946E 00	2.84037E 00	2.47159E 00	2.76823E 00

Table F-20

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: POSTIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.0420000D 01	1.287000E 00	1.322772E 00	-3.577232E-02	1
8.4239990D 01	1.342999E 00	1.373717E 00	-3.071785E-02	2
8.8159990D 01	1.452000E 00	1.423434E 00	2.856541E-02	1
9.2170000D 01	1.434999E 00	1.471608E 00	-3.660870E-02	3
9.5079990D 01	1.608999E 00	1.504868E 00	1.041317E-01	1
9.5560000D 01	1.485000E 00	1.510217E 00	-2.521706E-02	4
1.0030000D 02	1.561999E 00	1.560946E 00	1.052856E-03	2
1.1420000D 02	1.768000E 00	1.687839E 00	8.016109E-02	2
1.2520000D 02	1.714999E 00	1.765134E 00	-5.013466E-02	3
1.3813000D 02	1.775000E 00	1.829870E 00	-5.487061E-02	4
1.5420000D 02	1.870000E 00	1.870985E 00	-9.851456E-04	3
1.7537000D 02	1.879000E 00	1.858595E 00	2.040482E-02	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -3.21652E-01$

$C_2 = 2.72370E-02$

$C_3 = -8.44200E-05$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 5.600319E-02$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.31702E 00	3.28484E-02	1.17029E 00	1.46375E 00	1.24278E 00	1.39126E 00
90.	1.44588E 00	2.08364E-02	1.31083E 00	1.58092E 00	1.39879E 00	1.49297E 00
100.	1.55785E 00	1.93721E-02	1.42392E 00	1.69177E 00	1.51407E 00	1.60163E 00
110.	1.65294E 00	2.35998E-02	1.51559E 00	1.79028E 00	1.59960E 00	1.70627E 00
120.	1.73114E 00	2.73545E-02	1.59028E 00	1.87200E 00	1.66932E 00	1.79296E 00
130.	1.79246E 00	2.88584E-02	1.65008E 00	1.93484E 00	1.72724E 00	1.85768E 00
140.	1.83690E 00	2.84372E-02	1.69495E 00	1.97884E 00	1.77263E 00	1.90116E 00
150.	1.86445E 00	2.80797E-02	1.72286E 00	2.00603E 00	1.80099E 00	1.92791E 00
160.	1.87512E 00	3.16113E-02	1.72978E 00	2.02045E 00	1.80367E 00	1.94656E 00
170.	1.86890E 00	4.22196E-02	1.71040E 00	2.02740E 00	1.77348E 00	1.96432E 00
180.	1.84580E 00	5.99577E-02	1.66038E 00	2.03122E 00	1.71030E 00	1.98131E 00

Table F-21

THERMAL CONDUCTIVITY OF WANL BERYLLIUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.042000D 01	2.995999E 00	3.025182E 00	-2.918243E-02	1
8.378000D 01	3.059999E 00	3.076715E 00	-1.671600E-02	2
8.818999D 01	3.160000E 00	3.137474E 00	2.252579E-02	1
9.103999D 01	3.153000E 00	3.172586E 00	-1.958656E-02	3
9.512000D 01	3.162999E 00	3.217175E 00	-5.417538E-02	4
9.557999D 01	3.302999E 00	3.221784E 00	8.121586E-02	1
9.878000D 01	3.259999E 00	3.251488E 00	8.511543E-03	2
1.130000D 02	3.400000E 00	3.333755E 00	6.624413E-02	2
1.220000D 02	3.318000E 00	3.343869E 00	-2.586937E-02	3
1.352300D 02	3.301000E 00	3.299694E 00	1.305580E-03	4
1.533000D 02	3.058000E 00	3.125812E 00	-6.781197E-02	3
1.783700D 02	2.700999E 00	2.667447E 00	3.355217E-02	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 4.39135E-01$

$C_2 = 4.83016E-02$

$C_3 = -2.00757E-04$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 4.989871E-02$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	3.01842E 00	2.85783E-02	2.88846E 00	3.14838E 00	2.95383E 00	3.08301E 00
90.	3.16015E 00	1.83161E-02	3.04002E 00	3.28028E 00	3.11876E 00	3.20155E 00
100.	3.26173E 00	1.69593E-02	3.14262E 00	3.38084E 00	3.22340E 00	3.30006E 00
110.	3.32316E 00	2.06504E-02	3.20111E 00	3.44520E 00	3.27649E 00	3.36983E 00
120.	3.34443E 00	2.41614E-02	3.21914E 00	3.46973E 00	3.28983E 00	3.39904E 00
130.	3.32556E 00	2.58837E-02	3.19852E 00	3.45260E 00	3.26706E 00	3.38405E 00
140.	3.26653E 00	2.59627E-02	3.13941E 00	3.39365E 00	3.20785E 00	3.32521E 00
150.	3.16735E 00	2.57596E-02	3.04044E 00	3.29426E 00	3.10913E 00	3.22557E 00
160.	3.02802E 00	2.80087E-02	2.89870E 00	3.15734E 00	2.96472E 00	3.09132E 00
170.	2.84854E 00	3.55170E-02	2.71012E 00	2.98696E 00	2.76827E 00	2.92881E 00
180.	2.62891E 00	4.89645E-02	2.47091E 00	2.78690E 00	2.51825E 00	2.73957E 00

Table F-22

THERMAL CONDUCTIVITY OF TITANIUM: PREIRRADIATION RUNS 1 THRU 6

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.168999D 01	4.719000E-02	4.784002E-02	-6.500185E-04	1
8.662000D 01	4.917000E-02	4.891100E-02	2.589971E-04	2
8.973999D 01	4.962000E-02	4.958329E-02	3.670529E-05	1
9.643999D 01	5.065000E-02	5.101260E-02	-3.626011E-04	3
9.742999D 01	5.184000E-02	5.122213E-02	6.178729E-04	1
1.025000D 02	5.199000E-02	5.228845E-02	-2.984554E-04	4
1.028000D 02	5.289000E-02	5.235119E-02	5.388074E-04	2
1.181000D 02	5.556000E-02	5.549889E-02	6.110221E-05	2
1.240000D 02	5.695000E-02	5.668535E-02	2.646483E-04	5
1.282000D 02	5.801000E-02	5.752066E-02	4.893392E-04	3
1.341000D 02	5.990000E-02	5.868101E-02	1.218986E-03	6
1.432000D 02	6.007000E-02	6.044089E-02	-3.708936E-04	4
1.572000D 02	6.105000E-02	6.307757E-02	-2.027571E-03	3
1.803000D 02	6.424999E-02	6.724066E-02	-2.990663E-03	4
1.956000D 02	7.110000E-02	6.986952E-02	1.230478E-03	5
2.191000D 02	7.710999E-02	7.370770E-02	3.402293E-03	6
2.573999D 02	7.799000E-02	7.944530E-02	-1.455307E-03	5
2.910999D 02	8.399999E-02	8.396292E-02	3.707409E-05	6

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 2.85456E-02

C_2 = 2.54065E-04

C_3 = -2.18799E-07

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.451076E-03

d.f. = 15

t_α = 2.13

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	4.74704E-02	6.95495E-04	4.40430E-02	5.08979E-02	4.59890E-02	4.89518E-02
90.	4.96391E-02	5.51341E-04	4.63328E-02	5.29455E-02	4.84648E-02	5.08135E-02
100.	5.17641E-02	4.48781E-04	4.85288E-02	5.49993E-02	5.08082E-02	5.27200E-02
110.	5.38452E-02	3.96190E-04	5.06413E-02	5.70491E-02	5.30013E-02	5.46891E-02
120.	5.58826E-02	3.92351E-04	5.26809E-02	5.90844E-02	5.50469E-02	5.67183E-02
130.	5.78763E-02	4.21809E-04	5.46576E-02	6.10950E-02	5.69778E-02	5.87747E-02
140.	5.98262E-02	4.65644E-04	5.65801E-02	6.30721E-02	5.88344E-02	6.08180E-02
150.	6.17323E-02	5.10755E-04	5.84556E-02	6.50089E-02	6.06444E-02	6.28202E-02
160.	6.35946E-02	5.50088E-04	6.02892E-02	6.69000E-02	6.24230E-02	6.47663E-02
170.	6.54132E-02	5.80394E-04	6.20844E-02	6.87420E-02	6.41770E-02	6.66494E-02
180.	6.71881E-02	6.00681E-04	6.38429E-02	7.05332E-02	6.59086E-02	6.84675E-02
190.	6.89192E-02	6.11509E-04	6.55651E-02	7.22732E-02	6.76166E-02	7.02217E-02
200.	7.06065E-02	6.14857E-04	6.72497E-02	7.39633E-02	6.92968E-02	7.19162E-02
210.	7.22501E-02	6.14215E-04	6.88938E-02	7.56063E-02	7.09418E-02	7.35584E-02
220.	7.38499E-02	6.14779E-04	7.04932E-02	7.72066E-02	7.25404E-02	7.51594E-02
230.	7.54060E-02	6.23612E-04	7.20418E-02	7.87700E-02	7.40776E-02	7.67342E-02
240.	7.69182E-02	6.48957E-04	7.35324E-02	8.03040E-02	7.55360E-02	7.83005E-02
250.	7.83868E-02	6.98585E-04	7.49564E-02	8.18171E-02	7.68988E-02	7.98748E-02
260.	7.98116E-02	7.77988E-04	7.63046E-02	8.33185E-02	7.81544E-02	8.14686E-02
270.	8.11926E-02	8.89290E-04	7.75675E-02	8.48176E-02	7.92983E-02	8.30867E-02

Table F-23

THERMAL CONDUCTIVITY OF TITANIUM: POSTIRRADIATION RUNS 1 THRU 3

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.1819990 01	4.753000E-02	4.761160E-02	-8.160248E-05	1
8.9519990 01	4.920000E-02	4.926692E-02	-6.692484E-05	1
9.6980000 01	5.070000E-02	5.084595E-02	-1.459569E-04	1
1.0300000 02	5.214000E-02	5.210247E-02	3.752857E-05	2
1.2470000 02	5.685000E-02	5.650040E-02	3.495999E-04	3
1.4300000 02	6.080000E-02	6.004936E-02	7.506348E-04	2
1.7920000 02	6.403995E-02	6.663895E-02	-2.599001E-03	2
1.9460000 02	7.108998E-02	6.926876E-02	1.821220E-03	3
2.5480000 02	7.848996E-02	7.855493E-02	-6.496906E-05	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 2.84227E-02$

$C_2 = 2.52393E-04$

$C_3 = -2.18373E-07$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.341354E-03$

d.f. = 6

$t_\alpha = 2.45$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	4.72166E-02	8.65914E-04	4.33050E-02	5.11282E-02	4.50951E-02	4.93380E-02
90.	4.93693E-02	6.78720E-04	4.56862E-02	5.30523E-02	4.77064E-02	5.10321E-02
100.	5.14783E-02	5.62839E-04	4.79144E-02	5.50422E-02	5.00993E-02	5.28572E-02
110.	5.35436E-02	5.24722E-04	5.00148E-02	5.70724E-02	5.22581E-02	5.48292E-02
120.	5.55653E-02	5.47477E-04	5.20158E-02	5.91148E-02	5.42240E-02	5.69066E-02
130.	5.75433E-02	5.99748E-04	5.39434E-02	6.11431E-02	5.60739E-02	5.90127E-02
140.	5.94776E-02	6.56715E-04	5.58186E-02	6.31366E-02	5.78687E-02	6.10866E-02
150.	6.13682E-02	7.04805E-04	5.76559E-02	6.50806E-02	5.96414E-02	6.30950E-02
160.	6.32152E-02	7.38036E-04	5.94643E-02	6.69661E-02	6.14070E-02	6.50234E-02
170.	6.50185E-02	7.54985E-04	6.12474E-02	6.87895E-02	6.31688E-02	6.68682E-02
180.	6.67781E-02	7.57526E-04	6.30039E-02	7.05523E-02	6.49222E-02	6.86340E-02
190.	6.84940E-02	7.50797E-04	6.47279E-02	7.22601E-02	6.66546E-02	7.03334E-02
200.	7.01663E-02	7.43803E-04	6.64086E-02	7.39241E-02	6.83440E-02	7.19886E-02
210.	7.17950E-02	7.50069E-04	6.80298E-02	7.55602E-02	6.99573E-02	7.36326E-02
220.	7.33799E-02	7.86163E-04	6.95707E-02	7.71890E-02	7.14538E-02	7.53059E-02
230.	7.49211E-02	8.67297E-04	7.10077E-02	7.88345E-02	7.27962E-02	7.70460E-02
240.	7.64187E-02	1.00198E-03	7.23167E-02	8.05206E-02	7.39638E-02	7.88735E-02
250.	7.78726E-02	1.19104E-03	7.34777E-02	8.22674E-02	7.49545E-02	8.07906E-02
260.	7.92828E-02	1.43088E-03	7.44776E-02	8.40878E-02	7.57771E-02	8.27883E-02
270.	8.06493E-02	1.71708E-03	7.53110E-02	8.59876E-02	7.64425E-02	8.48562E-02

Table F-24

THERMAL CONDUCTIVITY OF TITANIUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 3

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.140999D 01	4.747000E-02	4.770564E-02	-2.356432E-04	1
8.884999D 01	4.936000E-02	4.933840E-02	2.160296E-05	1
9.601999D 01	5.112000E-02	5.088443E-02	2.355650E-04	1
1.008000D 02	5.171000E-02	5.190014E-02	-1.901388E-04	2
1.243000D 02	5.700000E-02	5.671940E-02	2.805963E-04	3
1.387000D 02	6.032000E-02	5.952933E-02	7.906668E-04	2
1.731000D 02	6.333995E-02	6.580174E-02	-2.461791E-03	2
1.952000D 02	7.120997E-02	6.950402E-02	1.705945E-03	3
2.562998D 02	7.825994E-02	7.840639E-02	-1.464486E-04	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 2.79428E-02$

$C_2 = 2.64106E-04$

$C_3 = -2.62244E-07$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.280861E-03$

d.f. = 6

$t_\alpha = 2.45$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	4.73929E-02	8.09074E-04	4.36812E-02	5.11047E-02	4.54107E-02	4.93752E-02
90.	4.95882E-02	6.34730E-04	4.60859E-02	5.30905E-02	4.80331E-02	5.11433E-02
100.	5.17310E-02	5.28616E-04	4.83361E-02	5.51258E-02	5.04359E-02	5.30261E-02
110.	5.38213E-02	4.96628E-04	5.04556E-02	5.71871E-02	5.26046E-02	5.50381E-02
120.	5.58592E-02	5.21847E-04	5.24707E-02	5.92478E-02	5.45807E-02	5.71378E-02
130.	5.78447E-02	5.74283E-04	5.44056E-02	6.12838E-02	5.64377E-02	5.92517E-02
140.	5.97776E-02	6.30726E-04	5.62797E-02	6.32756E-02	5.82324E-02	6.13229E-02
150.	6.16582E-02	6.78681E-04	5.81068E-02	6.52096E-02	5.99955E-02	6.33209E-02
160.	6.34863E-02	7.12643E-04	5.98952E-02	6.70775E-02	6.17404E-02	6.52323E-02
170.	6.52620E-02	7.31264E-04	6.16484E-02	6.88754E-02	6.34704E-02	6.70535E-02
180.	6.69851E-02	7.36110E-04	6.33657E-02	7.06045E-02	6.51816E-02	6.87886E-02
190.	6.86559E-02	7.31644E-04	6.50419E-02	7.22699E-02	6.68634E-02	7.04484E-02
200.	7.02742E-02	7.25682E-04	6.66674E-02	7.38810E-02	6.84963E-02	7.20521E-02
210.	7.18401E-02	7.29921E-04	6.82282E-02	7.54520E-02	7.00518E-02	7.36284E-02
220.	7.33535E-02	7.59150E-04	6.97055E-02	7.70013E-02	7.14935E-02	7.52134E-02
230.	7.48144E-02	8.27727E-04	7.10781E-02	7.85508E-02	7.27865E-02	7.68424E-02
240.	7.62229E-02	9.44786E-04	7.23234E-02	8.01223E-02	7.39082E-02	7.85376E-02
250.	7.75790E-02	1.11250E-03	7.34224E-02	8.17356E-02	7.48534E-02	8.03046E-02
260.	7.88826E-02	1.32838E-03	7.43615E-02	8.34036E-02	7.56280E-02	8.21371E-02
270.	8.01338E-02	1.58845E-03	7.51345E-02	8.51331E-02	7.62420E-02	8.40255E-02

Table F-25

THERMAL CONDUCTIVITY OF TITANIUM: CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^oK)	Thermal Cond (W/cm-^oK)	Thermal Cond (W/cm-^oK)	Residuals (input-calc)	
8.2000000 01	2.792999E-04	-5.143038E-04	7.936037E-04	1
8.9000000 01	-2.986998E-04	-4.439694E-04	1.452696E-04	1
9.7000000 01	-1.086000E-03	-3.686405E-04	-7.173594E-04	1
1.0300000 02	-4.144998E-04	-3.156811E-04	-9.881868E-05	2
1.2400000 02	-2.801998E-04	-1.542006E-04	-1.259992E-04	3
1.4300000 02	-3.279999E-04	-4.010304E-05	-2.878967E-04	2
1.7100000 02	2.400000E-04	7.262228E-05	1.673777E-04	4
1.8000000 02	-1.295000E-04	9.483269E-05	-2.243327E-04	2
1.9500000 02	1.008000E-04	1.166898E-04	-1.588982E-05	3
2.5500000 02	7.002000E-04	1.461922E-05	6.855805E-04	3
2.9600000 02	-4.860000E-04	-2.295106E-04	-2.564893E-04	4
3.9200000 02	-1.420000E-03	-1.354977E-03	-6.502309E-05	4

Least Squares Fit Coefficients

$\Delta k = C_1 + C_2T + C_3T^2$

C_1 = -1.64555E-03

C_2 = +1.72487E-05

C_3 = -4.21109E-08

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 4.585802E-04

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (^oK)	Δk (W/cm-^oK)	$S_{\overline{\Delta k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	-5.35157E-04	2.51408E-04	-1.71708E-03	6.46763E-04	-1.10334E-03	3.30240E-05
90.	-4.34258E-04	2.17548E-04	-1.58136E-03	7.12839E-04	-9.25916E-04	5.73995E-05
100.	-3.41782E-04	1.99918E-04	-1.46354E-03	7.79972E-04	-7.70997E-04	8.74335E-05
110.	-2.57727E-04	1.69371E-04	-1.36255E-03	8.47092E-04	-6.40506E-04	1.25051E-04
120.	-1.82095E-04	1.56501E-04	-1.27718E-03	9.12986E-04	-5.35786E-04	1.71596E-04
130.	-1.14885E-04	1.51184E-04	-1.20614E-03	9.76374E-04	-4.56560E-04	2.26790E-04
140.	-5.60971E-05	1.52336E-04	-1.14817E-03	1.03598E-03	-4.00376E-04	2.88182E-04
150.	-5.73136E-06	1.58200E-04	-1.10206E-03	1.09060E-03	-3.63263E-04	3.51800E-04
160.	3.62124E-05	1.69918E-04	-1.06670E-03	1.13912E-03	-3.41023E-04	4.13448E-04
170.	6.97337E-05	1.76948E-04	-1.04113E-03	1.18060E-03	-3.30168E-04	4.69635E-04
180.	9.48329E-05	1.87165E-04	-1.02455E-03	1.21422E-03	-3.28160E-04	5.17826E-04
190.	1.11510E-04	1.96821E-04	-1.01630E-03	1.23932E-03	-3.33305E-04	5.56325E-04
200.	1.19765E-04	2.05442E-04	-1.01588E-03	1.25540E-03	-3.44533E-04	5.84063E-04
210.	1.19597E-04	2.12756E-04	-1.02290E-03	1.26210E-03	-3.61232E-04	6.00426E-04
220.	1.11008E-04	2.18640E-04	-1.03715E-03	1.25916E-03	-3.83118E-04	6.05133E-04
230.	9.39942E-05	2.23082E-04	-1.05852E-03	1.24651E-03	-4.10171E-04	5.98160E-04
240.	6.85612E-05	2.26178E-04	-1.08703E-03	1.22415E-03	-4.42602E-04	5.79724E-04
250.	3.47027E-05	2.28113E-04	-1.12283E-03	1.19223E-03	-4.80833E-04	5.50238E-04
260.	-7.57514E-06	2.29177E-04	-1.16618E-03	1.15103E-03	-5.25515E-04	5.10365E-04
270.	-5.82747E-05	2.29764E-04	-1.21747E-03	1.10092E-03	-5.77541E-04	4.60992E-04
280.	-1.17397E-04	2.30386E-04	-1.27723E-03	1.04243E-03	-6.38069E-04	4.03275E-04
290.	-1.84944E-04	2.31671E-04	-1.34608E-03	9.76191E-04	-7.08520E-04	3.38631E-04
300.	-2.60910E-04	2.34354E-04	-1.42479E-03	9.02972E-04	-7.90549E-04	2.68728E-04
310.	-3.45298E-04	2.39237E-04	-1.51424E-03	8.23647E-04	-8.85973E-04	1.95377E-04
320.	-4.38106E-04	2.47130E-04	-1.61541E-03	7.39197E-04	-9.96619E-04	1.20407E-04
330.	-5.39344E-04	2.58765E-04	-1.72935E-03	6.50659E-04	-1.12415E-03	4.54658E-05
340.	-6.49001E-04	2.74723E-04	-1.85714E-03	5.59133E-04	-1.26987E-03	-2.81285E-05
350.	-7.67078E-04	2.95379E-04	-1.99985E-03	4.65697E-04	-1.43463E-03	-9.95225E-05
360.	-8.93578E-04	3.20904E-04	-2.15857E-03	3.71365E-04	-1.61882E-03	-1.68336E-04
370.	-1.02850E-03	3.51316E-04	-2.33406E-03	2.77064E-04	-1.82247E-03	-2.34528E-04
380.	-1.17185E-03	3.86496E-04	-2.52723E-03	1.83540E-04	-2.04533E-03	-2.98366E-04
390.	-1.32361E-03	4.26292E-04	-2.73864E-03	9.14065E-05	-2.28703E-03	-3.60194E-04

Table F-26

THERMAL CONDUCTIVITY OF TITANIUM: PREIRRADIATION RUNS 1 THRU 8

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.1689990 01	4.719000E-02	4.878283E-02	-1.592826E-03	1
8.6620000 01	4.917000E-02	4.967144E-02	-5.014427E-04	2
8.9739990 01	4.962000E-02	5.023592E-02	-6.159246E-04	1
9.6439990 01	5.065000E-02	5.145365E-02	-8.036532E-04	3
9.7429990 01	5.184000E-02	5.163423E-02	2.057739E-04	1
1.0250000 02	5.199000E-02	5.256157E-02	-5.715750E-04	4
1.0280000 02	5.289000E-02	5.261658E-02	2.734214E-04	2
1.1810000 02	5.556000E-02	5.544209E-02	1.179017E-04	2
1.2400000 02	5.695000E-02	5.654221E-02	4.077926E-04	5
1.2820000 02	5.801000E-02	5.732891E-02	6.810911E-04	3
1.3410000 02	5.990000E-02	5.843905E-02	1.460947E-03	6
1.4320000 02	6.007000E-02	6.016280E-02	-9.280443E-05	4
1.4450000 02	6.263995E-02	6.041019E-02	2.229761E-03	7
1.5720000 02	6.105000E-02	6.284195E-02	-1.791954E-03	3
1.7062000 02	6.964999E-02	6.544107E-02	4.208922E-03	8
1.8030000 02	6.424999E-02	6.733465E-02	-3.084660E-03	4
1.9560000 02	7.110000E-02	7.035989E-02	7.401109E-04	5
2.1910000 02	7.710999E-02	7.508320E-02	2.026796E-03	6
2.4240000 02	8.333999E-02	7.985812E-02	3.481865E-03	7
2.5739990 02	7.799000E-02	8.298045E-02	-4.990458E-03	5
2.9109990 02	8.399999E-02	9.013355E-02	-6.133556E-03	6
2.9916990 02	9.872997E-02	9.187490E-02	6.855071E-03	8
3.2398000 02	9.244996E-02	9.729695E-02	-4.846990E-03	7
4.0079980 02	1.170800E-01	1.147429E-01	2.337098E-03	8

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 3.46543E-02

C_2 = 1.66074E-04

C_3 = 8.42010E-08

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 3.068342E-03

d.f. = 21

t_α = 2.08

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	4.84792E-02	1.24169E-03	4.15942E-02	5.53641E-02	4.58964E-02	5.10619E-02
90.	5.02830E-02	1.06500E-03	4.35274E-02	5.70387E-02	4.80678E-02	5.24982E-02
100.	5.21038E-02	9.20268E-04	4.54407E-02	5.87668E-02	5.01896E-02	5.40179E-02
110.	5.39413E-02	8.12171E-04	4.73394E-02	6.05433E-02	5.22520E-02	5.56306E-02
120.	5.57957E-02	7.44229E-04	4.92285E-02	6.23629E-02	5.42477E-02	5.73437E-02
130.	5.76670E-02	7.16081E-04	5.11133E-02	6.42206E-02	5.61775E-02	5.91564E-02
140.	5.95551E-02	7.21841E-04	5.29987E-02	6.61114E-02	5.80536E-02	6.10565E-02
150.	6.14600E-02	7.51736E-04	5.48891E-02	6.80308E-02	5.98964E-02	6.30236E-02
160.	6.33817E-02	7.95592E-04	5.67885E-02	6.99749E-02	6.17269E-02	6.50365E-02
170.	6.53203E-02	8.45160E-04	5.87004E-02	7.19401E-02	6.35623E-02	6.70782E-02
180.	6.72758E-02	8.94662E-04	6.06278E-02	7.39236E-02	6.54148E-02	6.91366E-02
190.	6.92480E-02	9.40356E-04	6.25728E-02	7.59231E-02	6.72920E-02	7.12039E-02
200.	7.12371E-02	9.80026E-04	6.45373E-02	7.79369E-02	6.91987E-02	7.32756E-02
210.	7.32431E-02	1.01252E-03	6.65225E-02	7.99637E-02	7.11371E-02	7.53492E-02
220.	7.52659E-02	1.03749E-03	6.85288E-02	8.20030E-02	7.31079E-02	7.74238E-02
230.	7.73056E-02	1.05524E-03	7.05565E-02	8.40545E-02	7.51106E-02	7.95004E-02
240.	7.93621E-02	1.06666E-03	7.26053E-02	8.61189E-02	7.71434E-02	8.15807E-02
250.	8.14354E-02	1.07327E-03	7.46740E-02	8.81967E-02	7.92030E-02	8.36678E-02
260.	8.35255E-02	1.07723E-03	7.67615E-02	9.02895E-02	8.12849E-02	8.57661E-02
270.	8.56326E-02	1.08136E-03	7.88656E-02	9.23994E-02	8.33833E-02	8.78817E-02
280.	8.77564E-02	1.08921E-03	8.09840E-02	9.45287E-02	8.54908E-02	9.00219E-02
290.	8.98971E-02	1.10496E-03	8.31137E-02	9.66805E-02	8.75987E-02	9.21954E-02
300.	9.20546E-02	1.13314E-03	8.52512E-02	9.88580E-02	8.96977E-02	9.44115E-02
310.	9.42290E-02	1.17822E-03	8.73924E-02	1.01065E-01	9.17783E-02	9.66796E-02
320.	9.64202E-02	1.24412E-03	8.95334E-02	1.03307E-01	9.38324E-02	9.90080E-02
330.	9.86282E-02	1.33372E-03	9.16692E-02	1.05587E-01	9.58540E-02	1.01402E-01
340.	1.00853E-01	1.44868E-03	9.37954E-02	1.07911E-01	9.78398E-02	1.03866E-01
350.	1.03095E-01	1.58956E-03	9.59071E-02	1.10282E-01	9.97885E-02	1.06401E-01
360.	1.05353E-01	1.75603E-03	9.80000E-02	1.12707E-01	1.01701E-01	1.09006E-01
370.	1.07629E-01	1.94732E-03	1.00070E-01	1.15188E-01	1.03578E-01	1.11679E-01
380.	1.09921E-01	2.16242E-03	1.02113E-01	1.17729E-01	1.05423E-01	1.14419E-01
390.	1.12230E-01	2.40029E-03	1.04127E-01	1.20333E-01	1.07238E-01	1.17223E-01
400.	1.14556E-01	2.65997E-03	1.06110E-01	1.23003E-01	1.09023E-01	1.20089E-01

Table F-27

THERMAL CONDUCTIVITY OF TITANIUM: POSTIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.181999D 01	4.753000E-02	4.788466E-02	-3.546625E-04	1
8.951999D 01	4.920000E-02	4.940443E-02	-2.044365E-04	1
9.698000D 01	5.070000E-02	5.088355E-02	-1.835525E-04	1
1.030000D 02	5.214000E-02	5.208197E-02	5.802512E-05	2
1.247000D 02	5.685000E-02	5.643754E-02	4.124604E-04	3
1.430000D 02	6.080000E-02	6.015410E-02	6.459020E-04	2
1.704500D 02	6.987000E-02	6.580335E-02	4.066646E-03	4
1.792000D 02	6.403995E-02	6.762296E-02	-3.583014E-03	2
1.946000D 02	7.108998E-02	7.084751E-02	2.424717E-04	3
2.548000D 02	7.848996E-02	8.372253E-02	-5.232573E-03	3
2.937100D 02	9.704995E-02	9.227306E-02	4.776895E-03	4
3.923899D 02	1.141199E-01	1.147636E-01	-6.436706E-04	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 3.21701E-02$

$C_2 = 1.87208E-04$

$C_3 = 5.93306E-08$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 2.997020E-03$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	4.75265E-02	1.64550E-03	3.97995E-02	5.52535E-02	4.38076E-02	5.12453E-02
90.	4.94994E-02	1.42390E-03	4.20006E-02	5.69983E-02	4.62814E-02	5.27174E-02
100.	5.14842E-02	1.24277E-03	4.41517E-02	5.88167E-02	4.86756E-02	5.42929E-02
110.	5.34809E-02	1.10768E-03	4.62598E-02	6.07020E-02	5.09775E-02	5.59842E-02
120.	5.54894E-02	1.02258E-03	4.83328E-02	6.26461E-02	5.31784E-02	5.78005E-02
130.	5.75098E-02	9.86815E-04	5.03789E-02	6.46408E-02	5.52796E-02	5.97400E-02
140.	5.95421E-02	9.93472E-04	5.24064E-02	6.66777E-02	5.72969E-02	6.17873E-02
150.	6.15862E-02	1.03117E-03	5.44233E-02	6.87492E-02	5.92558E-02	6.39166E-02
160.	6.36422E-02	1.08778E-03	5.64366E-02	7.08478E-02	6.11838E-02	6.61005E-02
170.	6.57101E-02	1.15320E-03	5.84527E-02	7.29674E-02	6.31038E-02	6.83163E-02
180.	6.77898E-02	1.22004E-03	6.04768E-02	7.51027E-02	6.50325E-02	7.05470E-02
190.	6.98814E-02	1.28337E-03	6.25133E-02	7.72495E-02	6.69810E-02	7.27818E-02
200.	7.19849E-02	1.34007E-03	6.45654E-02	7.94044E-02	6.89563E-02	7.50134E-02
210.	7.41002E-02	1.38834E-03	6.66355E-02	8.15649E-02	7.09625E-02	7.72378E-02
220.	7.62274E-02	1.42735E-03	6.87252E-02	8.37295E-02	7.30015E-02	7.94532E-02
230.	7.83665E-02	1.45704E-03	7.08351E-02	8.58977E-02	7.50735E-02	8.16593E-02
240.	8.05174E-02	1.47801E-03	7.29653E-02	8.80695E-02	7.71771E-02	8.38577E-02
250.	8.26802E-02	1.49146E-03	7.51145E-02	9.02458E-02	7.93095E-02	8.60508E-02
260.	8.48548E-02	1.49925E-03	7.72813E-02	9.24283E-02	8.14665E-02	8.82431E-02
270.	8.70414E-02	1.50397E-03	7.94631E-02	9.46196E-02	8.36424E-02	9.04403E-02
280.	8.92398E-02	1.50889E-03	8.16565E-02	9.68230E-02	8.58297E-02	9.26498E-02
290.	9.14500E-02	1.51807E-03	8.38574E-02	9.90426E-02	8.80192E-02	9.48808E-02
300.	9.36722E-02	1.53626E-03	8.60609E-02	1.01283E-01	9.02002E-02	9.71441E-02
310.	9.59062E-02	1.56864E-03	8.82612E-02	1.03551E-01	9.23610E-02	9.94513E-02
320.	9.81520E-02	1.62040E-03	9.04521E-02	1.05852E-01	9.44899E-02	1.01814E-01
330.	1.00410E-01	1.69632E-03	9.26268E-02	1.08193E-01	9.65760E-02	1.04243E-01
340.	1.02679E-01	1.80015E-03	9.47781E-02	1.10580E-01	9.86109E-02	1.06748E-01
350.	1.04961E-01	1.93436E-03	9.68992E-02	1.13022E-01	1.00589E-01	1.09332E-01
360.	1.07254E-01	2.10014E-03	9.89834E-02	1.15525E-01	1.02508E-01	1.12000E-01
370.	1.09559E-01	2.29758E-03	1.01025E-01	1.18094E-01	1.04367E-01	1.14752E-01
380.	1.11876E-01	2.52610E-03	1.03018E-01	1.20735E-01	1.06167E-01	1.17585E-01
390.	1.14205E-01	2.78458E-03	1.04960E-01	1.23451E-01	1.07912E-01	1.20498E-01

Table F-28

THERMAL CONDUCTIVITY OF TITANIUM: POSTIRRADIATION-ANNEAL RUNS 1 THRU 4

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.140999D 01	4.747000E-02	4.814862E-02	-6.786175E-04	1
8.884999D 01	4.936000E-02	4.956864E-02	-2.086423E-04	1
9.601999D 01	5.112000E-02	5.094589E-02	1.741089E-04	1
1.008000D 02	5.171000E-02	5.186882E-02	-1.588240E-04	2
1.243000D 02	5.700000E-02	5.646178E-02	5.382188E-04	3
1.387000D 02	6.032000E-02	5.932177E-02	9.982251E-04	2
1.703000D 02	6.917995E-02	6.571925E-02	3.460705E-03	4
1.731000D 02	6.333995E-02	6.629413E-02	-2.954185E-03	2
1.952000D 02	7.120997E-02	7.087785E-02	3.321171E-04	3
2.562998D 02	7.825994E-02	8.397502E-02	-5.715072E-03	3
2.960198D 02	9.761000E-02	9.282368E-02	4.786313E-03	4
3.956299D 02	1.156000E-01	1.161740E-01	-5.739927E-04	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = 3.00969E-02$

$C_2 = 2.12937E-04$

$C_3 = 1.31588E-08$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 4.257042E-03$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	4.78805E-02	1.59243E-03	4.02953E-02	5.54658E-02	4.42817E-02	5.14794E-02
90.	4.97890E-02	1.37869E-03	4.24207E-02	5.71573E-02	4.66731E-02	5.29048E-02
100.	5.17141E-02	1.20528E-03	4.45028E-02	5.89254E-02	4.89902E-02	5.44380E-02
110.	5.36559E-02	1.07775E-03	4.65484E-02	6.07634E-02	5.12202E-02	5.60916E-02
120.	5.56145E-02	9.99804E-04	4.85654E-02	6.26635E-02	5.33549E-02	5.78740E-02
130.	5.75897E-02	9.70294E-04	5.05618E-02	6.46176E-02	5.53969E-02	5.97826E-02
140.	5.95817E-02	9.81836E-04	5.25455E-02	6.66178E-02	5.73627E-02	6.18006E-02
150.	6.15903E-02	1.02292E-03	5.45244E-02	6.86563E-02	5.92785E-02	6.39021E-02
160.	6.36157E-02	1.08168E-03	5.65052E-02	7.07262E-02	6.11711E-02	6.60602E-02
170.	6.56577E-02	1.14837E-03	5.84940E-02	7.28214E-02	6.30624E-02	6.82530E-02
180.	6.77165E-02	1.21596E-03	6.04961E-02	7.49370E-02	6.49685E-02	7.04646E-02
190.	6.97920E-02	1.27977E-03	6.25154E-02	7.70686E-02	6.68997E-02	7.26842E-02
200.	7.18842E-02	1.33685E-03	6.45553E-02	7.92130E-02	6.88629E-02	7.49055E-02
210.	7.39930E-02	1.38547E-03	6.66182E-02	8.13678E-02	7.08618E-02	7.71242E-02
220.	7.61186E-02	1.42483E-03	6.87056E-02	8.35316E-02	7.28985E-02	7.93387E-02
230.	7.82610E-02	1.45483E-03	7.08183E-02	8.57037E-02	7.49731E-02	8.15489E-02
240.	8.04200E-02	1.47598E-03	7.29560E-02	8.78839E-02	7.70843E-02	8.37557E-02
250.	8.25958E-02	1.48936E-03	7.51182E-02	9.00732E-02	7.92298E-02	8.59617E-02
260.	8.47881E-02	1.49666E-03	7.73032E-02	9.22731E-02	8.14057E-02	8.81706E-02
270.	8.69973E-02	1.50020E-03	7.95087E-02	9.44858E-02	8.36068E-02	9.03877E-02
280.	8.92231E-02	1.50300E-03	8.17317E-02	9.67146E-02	8.58263E-02	9.26199E-02
290.	9.14657E-02	1.50882E-03	8.39682E-02	9.89630E-02	8.80557E-02	9.48756E-02
300.	9.37250E-02	1.52209E-03	8.62138E-02	1.01236E-01	9.02850E-02	9.71649E-02
310.	9.60009E-02	1.54776E-03	8.84630E-02	1.03539E-01	9.25029E-02	9.94987E-02
320.	9.82935E-02	1.59093E-03	9.07099E-02	1.05877E-01	9.46980E-02	1.01889E-01
330.	1.00603E-01	1.65644E-03	9.29480E-02	1.08258E-01	9.68594E-02	1.04347E-01
340.	1.02929E-01	1.74829E-03	9.51704E-02	1.10687E-01	9.89779E-02	1.06880E-01
350.	1.05272E-01	1.86929E-03	9.73704E-02	1.13173E-01	1.01047E-01	1.09496E-01
360.	1.07631E-01	2.02098E-03	9.95414E-02	1.15721E-01	1.03064E-01	1.12199E-01
370.	1.10008E-01	2.20374E-03	1.01678E-01	1.18337E-01	1.05027E-01	1.14988E-01
380.	1.12400E-01	2.41714E-03	1.03773E-01	1.21027E-01	1.06938E-01	1.17863E-01
390.	1.14810E-01	2.66024E-03	1.05825E-01	1.23795E-01	1.08798E-01	1.20822E-01
400.	1.17236E-01	2.93192E-03	1.07829E-01	1.26643E-01	1.10610E-01	1.23862E-01

Table F-29

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: PREIRRADIATION RUNS 1 THRU 4

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.220000D 01	1.982000E-01	1.925653E-01	5.634725E-03	1
9.029999D 01	2.304000E-01	2.330306E-01	-2.630651E-03	1
9.750000D 01	2.588000E-01	2.678705E-01	-9.070516E-03	1
9.979999D 01	2.776999E-01	2.787759E-01	-1.075923E-03	2
1.269000D 02	3.770000E-01	3.991023E-01	-2.210230E-02	2
1.442000D 02	4.980000E-01	4.680414E-01	2.995861E-02	3
1.479000D 02	4.601000E-01	4.819889E-01	-2.188891E-02	2
1.520000D 02	5.384000E-01	4.971166E-01	4.128337E-02	4
2.116000D 02	6.568000E-01	6.780997E-01	-2.129972E-02	3
2.266000D 02	7.057000E-01	7.121782E-01	-6.478250E-03	4
2.655999D 02	7.800000E-01	7.791913E-01	8.087158E-04	3
2.875999D 02	8.101000E-01	8.032367F-01	6.863236E-03	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -2.94177E-01$

$C_2 = 6.76413E-03$

$C_3 = -1.02516E-05$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 2.169221E-02$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.81342E-01	1.33652E-02	1.23760E-01	2.38925E-01	1.51137E-01	2.11548E-01
90.	2.31556E-01	1.07846E-02	1.76807E-01	2.86305E-01	2.07183E-01	2.55929E-01
100.	2.79719E-01	8.90916E-03	2.26721E-01	3.32717E-01	2.59584E-01	2.99854E-01
110.	3.25832E-01	7.85656E-03	2.73691E-01	3.77973E-01	3.08076E-01	3.43588E-01
120.	3.69895E-01	7.61414E-03	3.17938E-01	4.21851E-01	3.52687E-01	3.87103E-01
130.	4.11907E-01	7.96486E-03	3.59682E-01	4.64131E-01	3.93906E-01	4.29907E-01
140.	4.51869E-01	8.61045E-03	3.99123E-01	5.04614E-01	4.32409E-01	4.71328E-01
150.	4.89780E-01	9.31706E-03	4.36424E-01	5.43135E-01	4.68723E-01	5.10836E-01
160.	5.25641E-01	9.94371E-03	4.71711E-01	5.79571E-01	5.03168E-01	5.48114E-01
170.	5.59452E-01	1.04164E-02	5.05068E-01	6.13835E-01	5.35911E-01	5.82993E-01
180.	5.91212E-01	1.07013E-02	5.36547E-01	6.45878E-01	5.67028E-01	6.15397E-01
190.	6.20923E-01	1.07933E-02	5.66165E-01	6.75680E-01	5.96530E-01	6.45316E-01
200.	6.48582E-01	1.07095E-02	5.93908E-01	7.03256E-01	6.24379E-01	6.72786E-01
210.	6.74192E-01	1.04921E-02	6.19734E-01	7.28650E-01	6.50480E-01	6.97904E-01
220.	6.97751E-01	1.02146E-02	6.43563E-01	7.51939E-01	6.74666E-01	7.20836E-01
230.	7.19260E-01	9.99252E-03	6.65284E-01	7.73236E-01	6.96677E-01	7.41843E-01
240.	7.38719E-01	9.98579E-03	6.84749E-01	7.92688E-01	7.16151E-01	7.61287E-01
250.	7.56127E-01	1.03785E-02	7.01781E-01	8.10474E-01	7.32672E-01	7.79583E-01
260.	7.71485E-01	1.13299E-02	7.16177E-01	8.26794E-01	7.45880E-01	7.97091E-01
270.	7.84793E-01	1.29179E-02	7.27734E-01	8.41852E-01	7.55599E-01	8.13987E-01
280.	7.96051E-01	1.51385E-02	7.36268E-01	8.55833E-01	7.61838E-01	8.30263E-01

Table F-30

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION RUNS 1 THRU 4

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.3489990 01	5.553000E-02	5.387462E-02	1.655377E-03	1
9.2679990 01	6.362998E-02	6.551570E-02	-1.885712E-03	1
9.7859990 01	7.397997E-02	7.208151E-02	1.898468E-03	2
1.0080000 02	7.154995E-02	7.580936E-02	-4.259408E-03	1
1.2610000 02	1.001000E-01	1.079291E-01	-7.829070E-03	2
1.3450000 02	1.298000E-01	1.186091E-01	1.119089E-02	3
1.4450000 02	1.461000E-01	1.313336E-01	1.476634E-02	4
1.4820000 02	1.228000E-01	1.360446E-01	-1.324463E-02	2
2.0340000 02	2.025000E-01	2.065079E-01	-4.007936E-03	3
2.2300000 02	2.347000E-01	2.316093E-01	3.090680E-03	4
2.5220000 02	2.652000E-01	2.690848E-01	-3.884852E-03	3
2.7770000 02	3.044000E-01	3.018894E-01	2.510548E-03	4

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -5.14522E-02$

$C_2 = 1.25689E-03$

$C_3 = 5.57967E-08$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 8.531298E-03$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	4.94562E-02	5.50770E-03	2.65066E-02	7.24058E-02	3.70088E-02	6.19036E-02
90.	6.21200E-02	4.35656E-03	4.04709E-02	8.37691E-02	5.22742E-02	7.19658E-02
100.	7.47949E-02	3.52273E-03	5.39351E-02	9.56546E-02	6.68335E-02	8.27562E-02
110.	8.74809E-02	3.06955E-03	6.69901E-02	1.07972E-01	8.05437E-02	9.44180E-02
120.	1.00178E-01	2.99364E-03	7.97449E-02	1.20611E-01	9.34126E-02	1.06944E-01
130.	1.12887E-01	3.18118E-03	9.23091E-02	1.33464E-01	1.05697E-01	1.20076E-01
140.	1.25606E-01	3.48336E-03	1.04780E-01	1.46432E-01	1.17734E-01	1.33479E-01
150.	1.38337E-01	3.79325E-03	1.17236E-01	1.59438E-01	1.29764E-01	1.46910E-01
160.	1.51079E-01	4.05163E-03	1.29734E-01	1.72423E-01	1.41922E-01	1.60235E-01
170.	1.63832E-01	4.22994E-03	1.42311E-01	1.85352E-01	1.54272E-01	1.73391E-01
180.	1.76596E-01	4.31789E-03	1.54987E-01	1.98206E-01	1.66838E-01	1.86355E-01
190.	1.89371E-01	4.31776E-03	1.67762E-01	2.10981E-01	1.79613E-01	1.99130E-01
200.	2.02158E-01	4.24333E-03	1.80624E-01	2.23692E-01	1.92568E-01	2.11748E-01
210.	2.14956E-01	4.12299E-03	1.93541E-01	2.36370E-01	2.05638E-01	2.24274E-01
220.	2.27764E-01	4.00409E-03	2.06466E-01	2.49063E-01	2.18715E-01	2.36814E-01
230.	2.40584E-01	3.95818E-03	2.19330E-01	2.61839E-01	2.31639E-01	2.49530E-01
240.	2.53416E-01	4.07498E-03	2.32048E-01	2.74783E-01	2.44206E-01	2.62625E-01
250.	2.66258E-01	4.43851E-03	2.44524E-01	2.87992E-01	2.56227E-01	2.76289E-01
260.	2.79111E-01	5.09419E-03	2.56655E-01	3.01568E-01	2.67599E-01	2.90624E-01
270.	2.91976E-01	6.04176E-03	2.68350E-01	3.15602E-01	2.78322E-01	3.05630E-01
280.	3.04852E-01	7.25583E-03	2.79541E-01	3.30163E-01	2.88454E-01	3.21250E-01

Table F-31

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION-ANNEAL RUNS 1 THRU 4

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.192999D 01	5.631000E-02	6.225829E-02	-5.948290E-03	1
9.078999D 01	7.650000E-02	7.370692E-02	2.793074E-03	1
9.765999D 01	9.441996E-02	8.271009E-02	1.170987E-02	1
9.993999D 01	7.465994E-02	8.572239E-02	-1.106244E-02	2
1.290000D 02	1.269000E-01	1.251779E-01	1.722038E-03	2
1.416000D 02	1.367000E-01	1.428973E-01	-6.197333E-03	3
1.487000D 02	1.488000E-01	1.530451E-01	-4.245102E-03	4
1.488000D 02	1.705000E-01	1.531888E-01	1.731116E-02	2
2.139000D 02	2.458000E-01	2.517301E-01	-5.930126E-03	3
2.280000D 02	2.670000E-01	2.743752E-01	-7.375240E-03	4
2.607000D 02	3.372999E-01	3.286769E-01	8.623004E-03	3
2.795999D 02	3.598000E-01	3.611994E-01	-1.399457E-03	4

Least Squares Fit Coefficients

$$k = C_1 + C_2 T + C_3 T^2$$

C_1 = -3.49361E-02

C_2 = 1.09078E-03

C_3 = 1.16601E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 9.589493E-03

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	5.97887E-02	6.02543E-03	3.41933E-02	8.53840E-02	4.61712E-02	7.34061E-02
90.	7.26786E-02	4.81139E-03	4.84315E-02	9.69257E-02	6.18049E-02	8.35524E-02
100.	8.58018E-02	3.94242E-03	6.23695E-02	1.09234E-01	7.68919E-02	9.47116E-02
110.	9.91582E-02	3.47877E-03	7.61040E-02	1.22212E-01	9.12962E-02	1.07020E-01
120.	1.12748E-01	3.40734E-03	8.97481E-02	1.35747E-01	1.05047E-01	1.20448E-01
130.	1.26571E-01	3.60777E-03	1.03415E-01	1.49726E-01	1.18417E-01	1.34724E-01
140.	1.40627E-01	3.92877E-03	1.17206E-01	1.64047E-01	1.31748E-01	1.49506E-01
150.	1.54916E-01	4.26007E-03	1.31201E-01	1.78630E-01	1.45288E-01	1.64544E-01
160.	1.69438E-01	4.53916E-03	1.45461E-01	1.93416E-01	1.59180E-01	1.79697E-01
170.	1.84194E-01	4.73443E-03	1.60024E-01	2.08364E-01	1.73494E-01	1.94894E-01
180.	1.99183E-01	4.83343E-03	1.74913E-01	2.23452E-01	1.88259E-01	2.10106E-01
190.	2.14405E-01	4.83627E-03	1.90132E-01	2.38677E-01	2.03475E-01	2.25335E-01
200.	2.29860E-01	4.75499E-03	2.05670E-01	2.54050E-01	2.19114E-01	2.40606E-01
210.	2.45548E-01	4.61551E-03	2.21497E-01	2.69600E-01	2.35117E-01	2.55979E-01
220.	2.61470E-01	4.46203E-03	2.37567E-01	2.85374E-01	2.51386E-01	2.71554E-01
230.	2.77625E-01	4.36404E-03	2.53814E-01	3.01436E-01	2.67762E-01	2.87488E-01
240.	2.94013E-01	4.41382E-03	2.70155E-01	3.17871E-01	2.84038E-01	3.03988E-01
250.	3.10634E-01	4.70792E-03	2.86491E-01	3.34777E-01	2.99994E-01	3.21274E-01
260.	3.27488E-01	5.31054E-03	3.02715E-01	3.52262E-01	3.15487E-01	3.39490E-01
270.	3.44576E-01	6.23463E-03	3.18726E-01	3.70426E-01	3.30486E-01	3.58666E-01
280.	3.61897E-01	7.45703E-03	3.34443E-01	3.89351E-01	3.45044E-01	3.78750E-01

Table F-32

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.300000D 01	-1.487000E-01	-1.434020E-01	-5.297959E-03	1
9.200000D 01	-1.738000E-01	-1.770259E-01	3.225923E-03	1
9.700000D 01	-1.895000E-01	-1.949629E-01	5.462945E-03	1
1.000000D 02	-2.025000E-01	-2.054704E-01	2.970397E-03	2
1.260000D 02	-2.725000E-01	-2.885330E-01	1.603305E-02	2
1.440000D 02	-3.586000E-01	-3.376325E-01	-2.096742E-02	3
1.480000D 02	-3.382000E-01	-3.476096E-01	9.409606E-03	2
1.520000D 02	-3.848000E-01	-3.572470E-01	-2.755296E-02	4
2.080000D 02	-4.410000E-01	-4.565113E-01	1.551127E-02	3
2.250000D 02	-4.640999E-01	-4.734735E-01	9.373605E-03	4
2.530000D 02	-4.899000E-01	-4.880407E-01	-1.859307E-03	3
2.780000D 02	-4.933000E-01	-4.869847E-01	-6.315231E-03	4

Least Squares Fit Coefficients

$\Delta k = C_1 + C_2T + C_3T^2$

$C_1 = +2.47725E-01$

$C_2 = -5.59326E-03$

$C_3 = +1.06130E-05$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.48823E-02$

d.f. = 9

$t_\alpha = 2.26$

$\alpha = 0.05$

Temperature (°K)	Δk (W/cm-°K)	$s_{\overline{\Delta k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	-1.31812E-01	9.43362E-03	-1.71634E-01	-9.19902E-02	-1.53132E-01	-1.10492E-01
90.	-1.69703E-01	7.52853E-03	-2.07395E-01	-1.32010E-01	-1.86717E-01	-1.52688E-01
100.	-2.05470E-01	6.15726E-03	-2.41869E-01	-1.69071E-01	-2.19386E-01	-1.91555E-01
110.	-2.39116E-01	5.41086E-03	-2.74904E-01	-2.03328E-01	-2.51344E-01	-2.26887E-01
120.	-2.70638E-01	5.27082E-03	-3.06319E-01	-2.34957E-01	-2.82550E-01	-2.58726E-01
130.	-3.00038E-01	5.55406E-03	-3.35938E-01	-2.64139E-01	-3.12591E-01	-2.87486E-01
140.	-3.27316E-01	6.02646E-03	-3.63603E-01	-2.91029E-01	-3.40936E-01	-3.13696E-01
150.	-3.52471E-01	6.51596E-03	-3.89187E-01	-3.15754E-01	-3.67197E-01	-3.37745E-01
160.	-3.75503E-01	6.92436E-03	-4.12599E-01	-3.38407E-01	-3.91152E-01	-3.59854E-01
170.	-3.96413E-01	7.20323E-03	-4.33779E-01	-3.59046E-01	-4.12692E-01	-3.80133E-01
180.	-4.15199E-01	7.33460E-03	-4.52696E-01	-3.77702E-01	-4.31775E-01	-3.98623E-01
190.	-4.31864E-01	7.32225E-03	-4.69349E-01	-3.94380E-01	-4.48412E-01	-4.15316E-01
200.	-4.46406E-01	7.19018E-03	-4.83759E-01	-4.09052E-01	-4.62655E-01	-4.30156E-01
210.	-4.58825E-01	6.98781E-03	-4.95982E-01	-4.21668E-01	-4.74618E-01	-4.43033E-01
220.	-4.69121E-01	6.79694E-03	-5.06097E-01	-4.32146E-01	-4.84482E-01	-4.53760E-01
230.	-4.77296E-01	6.73991E-03	-5.14218E-01	-4.40373E-01	-4.92528E-01	-4.62063E-01
240.	-4.83347E-01	6.96751E-03	-5.20484E-01	-4.46209E-01	-4.99093E-01	-4.67600E-01
250.	-4.87276E-01	7.61649E-03	-5.25059E-01	-4.49493E-01	-5.04489E-01	-4.70063E-01
260.	-4.89082E-01	8.75751E-03	-5.28107E-01	-4.50056E-01	-5.08874E-01	-4.69290E-01
270.	-4.88766E-01	1.03869E-02	-5.29781E-01	-4.47750E-01	-5.12240E-01	-4.65291E-01
280.	-4.86326E-01	1.24620E-02	-5.30195E-01	-4.42458E-01	-5.14490E-01	-4.58162E-01

Table F-33

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: PREIRRADIATION RUNS 1 THRU 7

Input Data		Calculated Data		Run No.
Temperature (^oK)	Thermal Cond (W/cm-^oK)	Thermal Cond (W/cm-^oK)	Residuals (input-calc)	
8.220000D 01	1.982000E-01	2.067994E-01	-8.599460E-03	1
9.029999D 01	2.304000E-01	2.465350E-01	-1.613504E-02	1
9.750000D 01	2.588000E-01	2.809527E-01	-2.215272E-02	1
9.979999D 01	2.776999E-01	2.917681E-01	-1.406819E-02	2
1.269000D 02	3.770000E-01	4.126729E-01	-3.567290E-02	2
1.442000D 02	4.980000E-01	4.835604E-01	1.443952E-02	3
1.479000D 02	4.601000E-01	4.980846E-01	-3.798461E-02	2
1.520000D 02	5.384000E-01	5.139169E-01	2.448314E-02	4
1.727000D 02	6.537000E-01	5.896431E-01	6.405693E-02	5
1.791000D 02	6.984000E-01	6.116346E-01	8.676541E-02	6
1.860000D 02	7.686000E-01	6.345921E-01	1.340079E-01	7
2.116000D 02	6.568000E-01	7.129487E-01	-5.614877E-02	3
2.266000D 02	7.057000E-01	7.538694E-01	-4.816937E-02	4
2.655999D 02	7.800000E-01	8.430056E-01	-6.300563E-02	3
2.663999D 02	8.304000E-01	8.445728E-01	-1.417279E-02	5
2.795999D 02	8.695000E-01	8.689215E-01	5.785227E-04	6
2.875999D 02	8.101000E-01	8.822892E-01	-7.218921E-02	4
2.965999D 02	9.413000E-01	8.960721E-01	4.522783E-02	7
3.470000D 02	9.170000E-01	9.487274E-01	-3.172737E-02	5
3.672998D 02	9.531000E-01	9.581725E-01	-5.072534E-03	6
3.943999D 02	1.015800E 00	9.602554E-01	5.554414E-02	7

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = -2.57275E-01

C_2 = 6.31934E-03

C_3 = -8.19548E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.535446E-02

d.f. = 18

t_α = 2.10

α = 0.05

Temperature (^oK)	k (W/cm-^oK)	$S_{\overline{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.95821E-01	2.86628E-02	6.49177E-02	3.26725E-01	1.35630E-01	2.56013E-01
90.	2.45083E-01	2.50787E-02	1.17465E-01	3.72701E-01	1.92417E-01	2.97748E-01
100.	2.92705E-01	2.19815E-02	1.67630E-01	4.17779E-01	2.46543E-01	3.38866E-01
110.	3.38688E-01	1.94199E-02	2.15497E-01	4.61878E-01	2.97906E-01	3.79469E-01
120.	3.83031E-01	1.74399E-02	2.61154E-01	5.04909E-01	3.46408E-01	4.19655E-01
130.	4.25736E-01	1.60669E-02	3.04694E-01	5.46778E-01	3.91996E-01	4.59477E-01
140.	4.66802E-01	1.52833E-02	3.46208E-01	5.87395E-01	4.34707E-01	4.98897E-01
150.	5.06228E-01	1.50144E-02	3.85784E-01	6.26673E-01	4.74698E-01	5.37759E-01
160.	5.44016E-01	1.51406E-02	4.23501E-01	6.64530E-01	5.12221E-01	5.75811E-01
170.	5.80164E-01	1.55259E-02	4.59434E-01	7.00894E-01	5.47560E-01	6.12768E-01
180.	6.14673E-01	1.60465E-02	4.93643E-01	7.35703E-01	5.80975E-01	6.48371E-01
190.	6.47543E-01	1.66036E-02	5.26182E-01	7.68904E-01	6.12675E-01	6.82411E-01
200.	6.78773E-01	1.71264E-02	5.57093E-01	8.00454E-01	6.42808E-01	7.14739E-01
210.	7.08365E-01	1.75669E-02	5.86408E-01	8.30323E-01	6.71475E-01	7.45256E-01
220.	7.36318E-01	1.78968E-02	6.14149E-01	8.58487E-01	6.98735E-01	7.73901E-01
230.	7.62632E-01	1.81024E-02	6.40329E-01	8.84934E-01	7.24617E-01	8.00647E-01
240.	7.87307E-01	1.81835E-02	6.64952E-01	9.09663E-01	7.49122E-01	8.25493E-01
250.	8.10343E-01	1.81519E-02	6.88008E-01	9.32677E-01	7.72224E-01	8.48462E-01
260.	8.31739E-01	1.80323E-02	7.09482E-01	9.53996E-01	7.93871E-01	8.69607E-01
270.	8.51496E-01	1.78634E-02	7.29349E-01	9.73644E-01	8.13983E-01	8.89009E-01
280.	8.69614E-01	1.76999E-02	7.47572E-01	9.91657E-01	8.32445E-01	9.06784E-01
290.	8.86093E-01	1.76137E-02	7.64106E-01	1.00808E 00	8.49105E-01	9.23082E-01
300.	9.00933E-01	1.76929E-02	7.78896E-01	1.02297E 00	8.63778E-01	9.38089E-01
310.	9.14134E-01	1.80353E-02	7.91876E-01	1.03639E 00	8.76260E-01	9.52008E-01
320.	9.25697E-01	1.87371E-02	8.02974E-01	1.04842E 00	8.86349E-01	9.65045E-01
330.	9.35620E-01	1.98780E-02	8.12108E-01	1.05913E 00	8.93876E-01	9.77364E-01
340.	9.43903E-01	2.15093E-02	8.19192E-01	1.06861E 00	8.98734E-01	9.89073E-01
350.	9.50548E-01	2.36516E-02	8.24137E-01	1.07696E 00	9.00880E-01	1.00022E 00
360.	9.55554E-01	2.62991E-02	8.26857E-01	1.08425E 00	9.00326E-01	1.01078E 00
370.	9.58920E-01	2.94319E-02	8.27265E-01	1.09057E 00	8.97113E-01	1.02073E 00
380.	9.60648E-01	3.30231E-02	8.25289E-01	1.09601E 00	8.91299E-01	1.03000E 00
390.	9.60735E-01	3.70464E-02	8.20860E-01	1.10061E 00	8.82938E-01	1.03853E 00
400.	9.59186E-01	4.14776E-02	8.13929E-01	1.10444E 00	8.72083E-01	1.04629E 00

Table F-34

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION RUNS 1 THRU 5

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.348999D 01	5.553000E-02	5.858908E-02	-3.059085E-03	1
9.267999D 01	6.362998E-02	6.839478E-02	-4.764795E-03	1
9.785999D 01	7.397997E-02	7.404119E-02	-6.121397E-05	2
1.008000D 02	7.154995E-02	7.728416E-02	-5.734205E-03	1
1.261000D 02	1.001000E-01	1.063367E-01	-6.236672E-03	2
1.345000D 02	1.298000E-01	1.164363E-01	1.336366E-02	3
1.445000D 02	1.461000E-01	1.287546E-01	1.734537E-02	4
1.482000D 02	1.228000E-01	1.333937E-01	-1.059371E-02	2
1.911400D 02	2.165999E-01	1.904418E-01	2.615809E-02	5
2.034000D 02	2.025000E-01	2.078148E-01	-5.314767E-03	3
2.230000D 02	2.347000E-01	2.365897E-01	-1.889765E-03	4
2.522000D 02	2.652000E-01	2.817426E-01	-1.654267E-02	3
2.777000D 02	3.044000E-01	3.234099E-01	-1.900989E-02	4
3.097598D 02	3.922000E-01	3.787540E-01	1.344597E-02	5
3.877798D 02	5.301000E-01	5.272053E-01	2.894700E-03	5

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = -1.80915E-02

C_2 = 7.84610E-04

C_3 = 1.60295E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.364975E-02

d.f. = 12

t_α = 2.18

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	5.49362E-02	7.31174E-03	2.11794E-02	8.86928E-02	3.89966E-02	7.08757E-02
90.	6.55073E-02	6.32704E-03	3.27096E-02	9.83050E-02	5.17144E-02	7.93002E-02
100.	7.63990E-02	5.50421E-03	4.43143E-02	1.08484E-01	6.43998E-02	8.83981E-02
110.	8.76113E-02	4.86334E-03	5.60225E-02	1.19200E-01	7.70091E-02	9.82133E-02
120.	9.91442E-02	4.42064E-03	6.78660E-02	1.30422E-01	8.95072E-02	1.08781E-01
130.	1.10998E-01	4.17839E-03	7.98782E-02	1.42117E-01	1.01889E-01	1.20107E-01
140.	1.23172E-01	4.11623E-03	9.20916E-02	1.54252E-01	1.14198E-01	1.32145E-01
150.	1.35666E-01	4.19343E-03	1.04537E-01	1.66795E-01	1.26525E-01	1.44808E-01
160.	1.48482E-01	4.36129E-03	1.17243E-01	1.79720E-01	1.38974E-01	1.57989E-01
170.	1.61617E-01	4.57581E-03	1.30233E-01	1.93001E-01	1.51642E-01	1.71593E-01
180.	1.75074E-01	4.80323E-03	1.43529E-01	2.06619E-01	1.64603E-01	1.85545E-01
190.	1.88851E-01	5.02029E-03	1.57146E-01	2.20556E-01	1.77907E-01	1.99795E-01
200.	2.02949E-01	5.21215E-03	1.71097E-01	2.34801E-01	1.91586E-01	2.14311E-01
210.	2.17367E-01	5.37041E-03	1.85390E-01	2.49343E-01	2.05659E-01	2.29074E-01
220.	2.32106E-01	5.49147E-03	2.00031E-01	2.64180E-01	2.20134E-01	2.44077E-01
230.	2.47165E-01	5.57570E-03	2.15022E-01	2.79308E-01	2.35010E-01	2.59320E-01
240.	2.62545E-01	5.62713E-03	2.30359E-01	2.94731E-01	2.50278E-01	2.74812E-01
250.	2.78245E-01	5.65315E-03	2.46038E-01	3.10453E-01	2.65922E-01	2.90569E-01
260.	2.94267E-01	5.66503E-03	2.62049E-01	3.26484E-01	2.81917E-01	3.06616E-01
270.	3.10608E-01	5.67789E-03	2.78380E-01	3.42836E-01	2.98230E-01	3.22986E-01
280.	3.27271E-01	5.71109E-03	2.95015E-01	3.59527E-01	3.14820E-01	3.39721E-01
290.	3.44254E-01	5.78744E-03	3.11933E-01	3.76574E-01	3.31637E-01	3.56870E-01
300.	3.61557E-01	5.93208E-03	3.29112E-01	3.94002E-01	3.48625E-01	3.74489E-01
310.	3.79181E-01	6.16982E-03	3.46526E-01	4.11836E-01	3.65731E-01	3.92631E-01
320.	3.97126E-01	6.52228E-03	3.64147E-01	4.30105E-01	3.82907E-01	4.11345E-01
330.	4.15391E-01	7.00512E-03	3.81945E-01	4.48838E-01	4.00120E-01	4.30662E-01
340.	4.33977E-01	7.62712E-03	3.99890E-01	4.68064E-01	4.17350E-01	4.50604E-01
350.	4.52884E-01	8.39062E-03	4.17955E-01	4.87812E-01	4.34592E-01	4.71175E-01
360.	4.72111E-01	9.29350E-03	4.36112E-01	5.08109E-01	4.51851E-01	4.92370E-01
370.	4.91658E-01	1.03309E-02	4.54340E-01	5.28977E-01	4.69137E-01	5.14180E-01
380.	5.11527E-01	1.14972E-02	4.72621E-01	5.50432E-01	4.86463E-01	5.36590E-01
390.	5.31715E-01	1.27863E-02	4.90943E-01	5.72488E-01	5.03841E-01	5.59590E-01

Table F-35

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION-ANNEAL RUNS 1 THRU 5

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.192999D 01	5.631000E-02	5.905038E-02	-2.740383E-03	1
9.078999D 01	7.650000E-02	7.200581E-02	4.494190E-03	1
9.765999D 01	9.441996E-02	8.207011E-02	1.234984E-02	1
9.993999D 01	7.465994E-02	8.541387E-02	-1.075393E-02	2
1.290000D 02	1.269000E-01	1.281900E-01	-1.290083E-03	2
1.416000D 02	1.367000E-01	1.468282E-01	-1.012820E-02	3
1.487000D 02	1.488000E-01	1.573550E-01	-8.554995E-03	4
1.488000D 02	1.705000E-01	1.575033E-01	1.299667E-02	2
1.829700D 02	2.193000E-01	2.084109E-01	1.088911E-02	5
2.139000D 02	2.458000E-01	2.548406E-01	-9.040594E-03	3
2.280000D 02	2.670000E-01	2.761165E-01	-9.116530E-03	4
2.607000D 02	3.372999E-01	3.257240E-01	1.157594E-02	3
2.795999D 02	3.598000E-01	3.545653E-01	5.234659E-03	4
2.965498D 02	3.757000E-01	3.805364E-01	-4.836380E-03	5
3.738098D 02	4.991000E-01	5.001783E-01	-1.078367E-03	5

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -5.94608E-02$

$C_2 = 1.43228E-03$

$C_3 = 1.73460E-07$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 9.624582E-03$

d.f. = 12

$t_\alpha = 2.18$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	5.62318E-02	5.19690E-03	3.23869E-02	8.00767E-02	4.49026E-02	6.75610E-02
90.	7.08495E-02	4.48153E-03	4.77048E-02	9.39941E-02	6.10797E-02	8.06192E-02
100.	8.55018E-02	3.89129E-03	6.28703E-02	1.08133E-01	7.70188E-02	9.39848E-02
110.	1.00189E-01	3.44078E-03	7.79069E-02	1.22471E-01	9.26880E-02	1.07690E-01
120.	1.14911E-01	3.14021E-03	9.28406E-02	1.36981E-01	1.08065E-01	1.21756E-01
130.	1.29667E-01	2.98721E-03	1.07698E-01	1.51636E-01	1.23155E-01	1.36179E-01
140.	1.44458E-01	2.96157E-03	1.22506E-01	1.66411E-01	1.38002E-01	1.50915E-01
150.	1.59284E-01	3.02939E-03	1.37288E-01	1.81281E-01	1.52680E-01	1.65888E-01
160.	1.74145E-01	3.15356E-03	1.52066E-01	1.96224E-01	1.67270E-01	1.81019E-01
170.	1.89040E-01	3.30247E-03	1.66858E-01	2.11222E-01	1.81841E-01	1.96239E-01
180.	2.03970E-01	3.45286E-03	1.81679E-01	2.26261E-01	1.96443E-01	2.11497E-01
190.	2.18935E-01	3.58931E-03	1.96541E-01	2.41328E-01	2.11110E-01	2.26759E-01
200.	2.33934E-01	3.70247E-03	2.11453E-01	2.56414E-01	2.25862E-01	2.42005E-01
210.	2.48968E-01	3.78765E-03	2.26420E-01	2.71516E-01	2.40711E-01	2.57225E-01
220.	2.64037E-01	3.84379E-03	2.41444E-01	2.86629E-01	2.55657E-01	2.72416E-01
230.	2.79140E-01	3.87306E-03	2.56523E-01	3.01757E-01	2.70697E-01	2.87583E-01
240.	2.94278E-01	3.88068E-03	2.71655E-01	3.16901E-01	2.85818E-01	3.02738E-01
250.	3.09451E-01	3.87522E-03	2.86832E-01	3.32069E-01	3.01003E-01	3.17899E-01
260.	3.24658E-01	3.86878E-03	3.02045E-01	3.47272E-01	3.16224E-01	3.33092E-01
270.	3.39900E-01	3.87734E-03	3.17280E-01	3.62521E-01	3.31448E-01	3.48353E-01
280.	3.55177E-01	3.92028E-03	3.32522E-01	3.77833E-01	3.46631E-01	3.63723E-01
290.	3.70489E-01	4.01916E-03	3.47751E-01	3.93226E-01	3.61727E-01	3.79251E-01
300.	3.85835E-01	4.19521E-03	3.62947E-01	4.08723E-01	3.76689E-01	3.94981E-01
310.	4.01216E-01	4.46621E-03	3.78085E-01	4.24347E-01	3.91480E-01	4.10952E-01
320.	4.16632E-01	4.84399E-03	3.93142E-01	4.40121E-01	4.06072E-01	4.27191E-01
330.	4.32082E-01	5.33384E-03	4.08094E-01	4.56070E-01	4.20454E-01	4.43710E-01
340.	4.47567E-01	5.93559E-03	4.22916E-01	4.72218E-01	4.34627E-01	4.60506E-01
350.	4.63087E-01	6.64566E-03	4.37589E-01	4.88584E-01	4.48599E-01	4.77574E-01
360.	4.78641E-01	7.45891E-03	4.52096E-01	5.05186E-01	4.62381E-01	4.94901E-01
370.	4.94230E-01	8.37023E-03	4.66424E-01	5.22036E-01	4.75983E-01	5.12477E-01

Table F-38

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P6 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (^oK)	Thermal Cond ($W/cm-^oK$)	Thermal Cond ($W/cm-^oK$)	Residuals (input-calc)	
8.212999D 01	5.648000E-02	6.451088E-02	-8.030884E-03	1
9.042999D 01	8.427995E-02	7.584620E-02	8.433759E-03	1
9.650000D 01	1.076100E-01	8.408451E-02	2.352548E-02	1
9.939000D 01	7.148999E-02	8.799165E-02	-1.650167E-02	2
1.281300D 02	1.380600E-01	1.263105E-01	1.174951E-02	2
1.281400D 02	1.027700E-01	1.263237E-01	-2.355373E-02	3
1.465000D 02	1.925400E-01	1.502929E-01	4.224712E-02	2
1.511100D 02	1.296800E-01	1.562488E-01	-2.656883E-02	4
1.609300D 02	1.391700E-01	1.688574E-01	-2.968246E-02	5
1.834200D 02	2.016500E-01	1.972890E-01	4.360914E-03	3
2.184100D 02	2.848800E-01	2.403451E-01	4.453492E-02	3
2.267000D 02	2.363900E-01	2.503346E-01	-1.394463E-02	4
2.451600D 02	2.484600E-01	2.722878E-01	-2.382785E-02	5
2.753999D 02	3.202100E-01	3.073819E-01	1.282805E-02	4
3.007300D 02	3.303800E-01	3.359482E-01	-5.568206E-03	5

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = -5.20326E-02

C_2 = 1.46744E-03

C_3 = -5.89585E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.579747E-02

d.f. = 12

t_α = 2.18

α = 0.05

Temperature (^oK)	k ($W/cm-^oK$)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	6.15889E-02	1.50786E-02	0.0	1.26729E-01	2.87175E-02	9.44602E-02
90.	7.52609E-02	1.24046E-02	1.28588E-02	1.37663E-01	4.82190E-02	1.02303E-01
100.	8.88151E-02	1.03294E-02	2.82360E-02	1.49394E-01	6.62971E-02	1.11333E-01
110.	1.02251E-01	8.94131E-03	4.27303E-02	1.61772E-01	8.27579E-02	1.21745E-01
120.	1.15570E-01	8.27262E-03	5.65104E-02	1.74629E-01	9.75353E-02	1.33604E-01
130.	1.28770E-01	8.21935E-03	6.97460E-02	1.87794E-01	1.10852E-01	1.46688E-01
140.	1.41852E-01	8.56735E-03	8.25938E-02	2.01111E-01	1.23176E-01	1.60529E-01
150.	1.54817E-01	9.09318E-03	9.51872E-02	2.14447E-01	1.34994E-01	1.74640E-01
160.	1.67664E-01	9.63299E-03	1.07632E-01	2.27695E-01	1.46664E-01	1.88664E-01
170.	1.80392E-01	1.00871E-02	1.20008E-01	2.40777E-01	1.58402E-01	2.02382E-01
180.	1.93003E-01	1.04034E-02	1.32364E-01	2.53642E-01	1.70324E-01	2.15683E-01
190.	2.05496E-01	1.05622E-02	1.44727E-01	2.66266E-01	1.82471E-01	2.28522E-01
200.	2.17871E-01	1.05691E-02	1.57096E-01	2.78646E-01	1.94830E-01	2.40912E-01
210.	2.30128E-01	1.04554E-02	1.69446E-01	2.90810E-01	2.07335E-01	2.52921E-01
220.	2.42267E-01	1.02783E-02	1.81729E-01	3.02805E-01	2.19861E-01	2.64674E-01
230.	2.54289E-01	1.01303E-02	1.93869E-01	3.14708E-01	2.32204E-01	2.76373E-01
240.	2.66192E-01	1.01409E-02	2.05764E-01	3.26619E-01	2.44085E-01	2.88299E-01
250.	2.77977E-01	1.04639E-02	2.17289E-01	3.38666E-01	2.55166E-01	3.00788E-01
260.	2.89645E-01	1.12464E-02	2.28294E-01	3.50995E-01	2.65128E-01	3.14162E-01
270.	3.01194E-01	1.25826E-02	2.38623E-01	3.63766E-01	2.73764E-01	3.28624E-01
280.	3.12626E-01	1.44974E-02	2.48115E-01	3.77136E-01	2.81022E-01	3.44230E-01
290.	3.23940E-01	1.69673E-02	2.56627E-01	3.91252E-01	2.86951E-01	3.60928E-01
300.	3.35135E-01	1.99481E-02	2.64045E-01	4.06226E-01	2.91649E-01	3.78622E-01

Table F-39

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P7 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.200999D 01	6.886995E-02	7.057729E-02	-1.707256E-03	1
8.946999D 01	8.762997E-02	8.269846E-02	4.931509E-03	1
9.553999D 01	1.049500E-01	9.238857E-02	1.246142E-02	1
9.806999D 01	9.004998E-02	9.638166E-02	-6.331682E-03	2
1.239600D 02	1.403400E-01	1.356972E-01	4.642785E-03	2
1.251900D 02	1.278600E-01	1.374949E-01	-9.634972E-03	3
1.422700D 02	1.834900E-01	1.618006E-01	2.168936E-02	2
1.468300D 02	1.561100E-01	1.680823E-01	-1.197231E-02	4
1.553800D 02	1.630700E-01	1.796247E-01	-1.655471E-02	5
1.750900D 02	2.047600E-01	2.050621E-01	-3.021359E-04	3
1.800700D 02	1.907499E-01	2.112308E-01	-2.048081E-02	6
2.098400D 02	2.714400E-01	2.459313E-01	2.550870E-02	3
2.151600D 02	2.456500E-01	2.517399E-01	-6.089926E-03	4
2.308900D 02	2.618800E-01	2.682186E-01	-6.338596E-03	5
2.631199D 02	3.217900E-01	2.987328E-01	2.305716E-02	4
2.768799D 02	2.814900E-01	3.104299E-01	-2.892996E-02	6
2.846599D 02	3.399300E-01	3.166913E-01	2.313870E-02	5
3.496199D 02	3.519599E-01	3.590370E-01	-7.077038E-03	6

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = -7.81010E-02

C_2 = 1.98534E-03

C_3 = -2.10233E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.698424E-02

d.f. = 15

t_α = 2.13

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	6.72713E-02	8.97681E-03	2.63527E-02	1.08190E-01	4.81507E-02	8.63919E-02
90.	8.35508E-02	7.64358E-03	4.38796E-02	1.23222E-01	6.72699E-02	9.98315E-02
100.	9.94097E-02	6.54319E-03	6.06415E-02	1.39178E-01	8.54727E-02	1.13347E-01
110.	1.14848E-01	5.70348E-03	7.66865E-02	1.53010E-01	1.02700E-01	1.26997E-01
120.	1.29866E-01	5.14457E-03	9.20667E-02	1.67666E-01	1.18908E-01	1.40824E-01
130.	1.44464E-01	4.86132E-03	1.06835E-01	1.82093E-01	1.34109E-01	1.54818E-01
140.	1.58641E-01	4.81144E-03	1.21041E-01	1.96741E-01	1.48393E-01	1.68889E-01
150.	1.72398E-01	4.92498E-03	1.34731E-01	2.10064E-01	1.61907E-01	1.82888E-01
160.	1.85734E-01	5.12844E-03	1.47944E-01	2.23523E-01	1.74810E-01	1.96657E-01
170.	1.98650E-01	5.36207E-03	1.60713E-01	2.36586E-01	1.87228E-01	2.10071E-01
180.	2.11145E-01	5.58468E-03	1.73063E-01	2.49227E-01	1.99249E-01	2.23040E-01
190.	2.23720E-01	5.77113E-03	1.85012E-01	2.61427E-01	2.10927E-01	2.35512E-01
200.	2.34874E-01	5.90875E-03	1.96571E-01	2.73177E-01	2.22288E-01	2.47460E-01
210.	2.46108E-01	5.99449E-03	2.07744E-01	2.84471E-01	2.33339E-01	2.58876E-01
220.	2.56921E-01	6.03376E-03	2.18530E-01	2.95313E-01	2.44069E-01	2.69773E-01
230.	2.67314E-01	6.04007E-03	2.28918E-01	3.05710E-01	2.54449E-01	2.80179E-01
240.	2.77286E-01	6.03566E-03	2.38894E-01	3.15679E-01	2.64430E-01	2.90142E-01
250.	2.86838E-01	6.05214E-03	2.48434E-01	3.25243E-01	2.73947E-01	2.99729E-01
260.	2.95970E-01	6.12992E-03	2.57509E-01	3.34431E-01	2.82913E-01	3.09027E-01
270.	3.04681E-01	6.31515E-03	2.66085E-01	3.43277E-01	2.91230E-01	3.18132E-01
280.	3.12972E-01	6.65354E-03	2.74118E-01	3.51825E-01	2.98800E-01	3.27144E-01
290.	3.20842E-01	7.18192E-03	2.81564E-01	3.60120E-01	3.05544E-01	3.36139E-01
300.	3.28291E-01	7.92249E-03	2.88373E-01	3.68210E-01	3.11416E-01	3.45166E-01
310.	3.35321E-01	8.88232E-03	2.94496E-01	3.76145E-01	3.16401E-01	3.54240E-01
320.	3.41929E-01	1.00573E-02	2.99886E-01	3.83972E-01	3.20507E-01	3.63351E-01
330.	3.48117E-01	1.14380E-02	3.04502E-01	3.91733E-01	3.23755E-01	3.72480E-01
340.	3.53885E-01	1.30131E-02	3.08211E-01	3.99459E-01	3.26167E-01	3.81603E-01
350.	3.59233E-01	1.47721E-02	3.11287E-01	4.07178E-01	3.27768E-01	3.90697E-01

Table F-36

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P4 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.2140000D 01	6.323999E-02	6.561565E-02	-2.375662E-03	1
9.0340000D 01	7.907999E-02	7.651469E-02	2.563298E-03	1
9.7090000D 01	9.388000E-02	8.536977E-02	8.510232E-03	1
9.9569990D 01	8.164999E-02	8.859515E-02	-6.945193E-03	2
1.2811000D 02	1.177500E-01	1.246585E-01	-6.908536E-03	3
1.2822000D 02	1.250800E-01	1.247937E-01	2.862811E-04	2
1.4871000D 02	1.622400E-01	1.494823E-01	1.275766E-02	2
1.5018000D 02	1.442699E-01	1.512150E-01	-6.945074E-03	4
1.5935000D 02	1.553000E-01	1.619077E-01	-6.607771E-03	5
1.8285000D 02	1.856000E-01	1.883950E-01	-2.795041E-03	3
1.9745000D 02	2.151000E-01	2.041980E-01	1.091200E-02	6
2.2135000D 02	2.448699E-01	2.289441E-01	1.592582E-02	3
2.2423000D 02	2.236800E-01	2.318354E-01	-8.155465E-03	4
2.4141000D 02	2.386300E-01	2.486718E-01	-1.004183E-02	5
2.7692990D 02	2.864900E-01	2.812504E-01	5.239546E-03	4
3.0096000D 02	3.001000E-01	3.015950E-01	-1.485050E-03	5
3.1488990D 02	3.066500E-01	3.127425E-01	-6.092548E-03	6
4.0530980D 02	3.760800E-01	3.739216E-01	2.158344E-03	6

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = -5.24246E-02

C_2 = 1.53496E-03

C_3 = -1.19182E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 8.385058E-03

d.f. = 15

t_α = 2.13

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\overline{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	6.27443E-02	4.27864E-03	4.26934E-02	8.27953E-02	5.36308E-02	7.18578E-02
90.	7.60679E-02	3.73838E-03	5.65131E-02	9.56227E-02	6.81051E-02	8.40306E-02
100.	8.91529E-02	3.27487E-03	6.99789E-02	1.08327E-01	8.21774E-02	9.61284E-02
110.	1.02000E-01	2.89632E-03	8.31041E-02	1.20895E-01	9.58305E-02	1.08169E-01
120.	1.14608E-01	2.61031E-03	9.59025E-02	1.33314E-01	1.09048E-01	1.20168E-01
130.	1.26978E-01	2.42050E-03	1.08399E-01	1.45568E-01	1.21822E-01	1.32134E-01
140.	1.39110E-01	2.32331E-03	1.20577E-01	1.57643E-01	1.34161E-01	1.44058E-01
150.	1.51003E-01	2.30522E-03	1.32480E-01	1.69526E-01	1.46093E-01	1.55913E-01
160.	1.62658E-01	2.34651E-03	1.44112E-01	1.81204E-01	1.57660E-01	1.67656E-01
170.	1.74075E-01	2.42582E-03	1.55482E-01	1.92667E-01	1.68908E-01	1.79242E-01
180.	1.85253E-01	2.52446E-03	1.66601E-01	2.03905E-01	1.79876E-01	1.90630E-01
190.	1.96193E-01	2.62820E-03	1.77476E-01	2.14910E-01	1.90595E-01	2.01791E-01
200.	2.06894E-01	2.72712E-03	1.88113E-01	2.25675E-01	2.01085E-01	2.12703E-01
210.	2.17357E-01	2.81497E-03	1.99518E-01	2.36197E-01	2.11361E-01	2.23353E-01
220.	2.27582E-01	2.88840E-03	2.08692E-01	2.46472E-01	2.21430E-01	2.33734E-01
230.	2.37568E-01	2.94635E-03	2.18638E-01	2.56499E-01	2.31293E-01	2.43844E-01
240.	2.47317E-01	2.98979E-03	2.28355E-01	2.66278E-01	2.40948E-01	2.53685E-01
250.	2.56826E-01	3.02153E-03	2.37842E-01	2.75811E-01	2.50390E-01	2.63262E-01
260.	2.66098E-01	3.04615E-03	2.47095E-01	2.85100E-01	2.59609E-01	2.72586E-01
270.	2.75130E-01	3.07017E-03	2.56111E-01	2.94150E-01	2.68591E-01	2.81670E-01
280.	2.83925E-01	3.10195E-03	2.64882E-01	3.02968E-01	2.77318E-01	2.90532E-01
290.	2.92481E-01	3.15143E-03	2.73401E-01	3.11561E-01	2.85769E-01	2.99194E-01
300.	3.00799E-01	3.22979E-03	2.81660E-01	3.19938E-01	2.93920E-01	3.07679E-01
310.	3.08879E-01	3.34847E-03	2.89647E-01	3.28110E-01	3.01746E-01	3.16011E-01
320.	3.16720E-01	3.51798E-03	2.97351E-01	3.36088E-01	3.09226E-01	3.24213E-01
330.	3.24322E-01	3.74687E-03	3.04760E-01	3.43885E-01	3.16342E-01	3.32303E-01
340.	3.31687E-01	4.04097E-03	3.11861E-01	3.51513E-01	3.23080E-01	3.40294E-01
350.	3.38813E-01	4.40320E-03	3.18640E-01	3.58986E-01	3.29434E-01	3.48192E-01
360.	3.45701E-01	4.83422E-03	3.25085E-01	3.66316E-01	3.35404E-01	3.55997E-01
370.	3.52350E-01	5.33296E-03	3.31183E-01	3.73516E-01	3.40991E-01	3.63709E-01
380.	3.58761E-01	5.89748E-03	3.36926E-01	3.80596E-01	3.46199E-01	3.71322E-01
390.	3.64933E-01	6.52545E-03	3.42302E-01	3.87565E-01	3.51034E-01	3.78833E-01
400.	3.70868E-01	7.21452E-03	3.47306E-01	3.94429E-01	3.55501E-01	3.86234E-01
410.	3.76563E-01	7.96255E-03	3.51933E-01	4.01193E-01	3.59603E-01	3.93524E-01

Table F-37

THERMAL CONDUCTIVITY OF PO-3·GRAPHITE: IML RUN P5 with LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.219999D 01	6.248000E-02	6.306552E-02	-5.855300E-04	1
9.045999D 01	7.895994E-02	7.519168E-02	3.768265E-03	1
9.720999D 01	9.425998E-02	8.494413E-02	9.315848E-03	1
9.929999D 01	8.161998E-02	8.793741E-02	-6.317437E-03	2
1.271300D 02	1.181700E-01	1.266052E-01	-8.435249E-03	3
1.277200D 02	1.273100E-01	1.274011E-01	-9.107590E-05	2
1.477000D 02	1.462200E-01	1.537632E-01	-7.543206E-03	4
1.478100D 02	1.661200E-01	1.539052E-01	1.221478E-02	2
1.562300D 02	1.581600E-01	1.646704E-01	-6.510437E-03	5
1.812200D 02	1.897500E-01	1.954278E-01	-5.677879E-03	3
1.945100D 02	2.176700E-01	2.110591E-01	6.611884E-03	6
2.187700D 02	2.519700E-01	2.382894E-01	1.368159E-02	3
2.199700D 02	2.318200E-01	2.395917E-01	-7.771730E-03	4
2.359000D 02	2.483700E-01	2.565926E-01	-8.122637E-03	5
2.705699D 02	3.021800E-01	2.908006E-01	1.137936E-02	4
2.925598D 02	3.156199E-01	3.107745E-01	4.845440E-03	5
3.007813D 02	3.141299E-01	3.254591E-01	-1.133911E-02	6
3.977300D 02	3.877700E-01	3.871222E-01	5.777478E-04	6

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = -6.80715E-02

C_2 = 1.71298E-03

C_3 = -1.42892E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 8.687984E-03

d.f. = 15

t_α = 2.13

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	5.98217E-02	4.44919E-03	3.90319E-02	8.06115E-02	5.03471E-02	6.92963E-02
90.	7.45223E-02	3.87379E-03	5.42607E-02	9.47838E-02	6.62711E-02	8.27734E-02
100.	8.89372E-02	3.38254E-03	6.90787E-02	1.08796E-01	8.17324E-02	9.61420E-02
110.	1.03066E-01	2.98353E-03	8.35001E-02	1.22632E-01	9.67113E-02	1.09421E-01
120.	1.16910E-01	2.68511E-03	9.75404E-02	1.36279E-01	1.11190E-01	1.22629E-01
130.	1.30467E-01	2.49116E-03	1.11216E-01	1.49718E-01	1.25161E-01	1.35773E-01
140.	1.43739E-01	2.39663E-03	1.24542E-01	1.62935E-01	1.38634E-01	1.48844E-01
150.	1.56725E-01	2.38603E-03	1.37534E-01	1.75915E-01	1.51642E-01	1.61807E-01
160.	1.69425E-01	2.43683E-03	1.50205E-01	1.88644E-01	1.64234E-01	1.74615E-01
170.	1.81839E-01	2.52560E-03	1.62568E-01	2.01111E-01	1.76460E-01	1.87219E-01
180.	1.93968E-01	2.63231E-03	1.74632E-01	2.13304E-01	1.88361E-01	1.99575E-01
190.	2.05811E-01	2.74217E-03	1.86405E-01	2.25216E-01	1.99970E-01	2.11651E-01
200.	2.17369E-01	2.84511E-03	1.97895E-01	2.36840E-01	2.11307E-01	2.23428E-01
210.	2.28639E-01	2.93506E-03	2.09106E-01	2.48172E-01	2.22387E-01	2.34890E-01
220.	2.39624E-01	3.00905E-03	2.20040E-01	2.59208E-01	2.33215E-01	2.46034E-01
230.	2.50324E-01	3.06672E-03	2.30699E-01	2.69948E-01	2.43792E-01	2.56856E-01
240.	2.60738E-01	3.10975E-03	2.41083E-01	2.80393E-01	2.54114E-01	2.67362E-01
250.	2.70866E-01	3.14204E-03	2.51187E-01	2.90544E-01	2.64173E-01	2.77558E-01
260.	2.80708E-01	3.16953E-03	2.61019E-01	3.00407E-01	2.73957E-01	2.87459E-01
270.	2.90265E-01	3.20027E-03	2.70544E-01	3.09986E-01	2.83448E-01	2.97081E-01
280.	2.99535E-01	3.24433E-03	2.79792E-01	3.19279E-01	2.92625E-01	3.06446E-01
290.	3.08520E-01	3.31340E-03	2.88715E-01	3.28326E-01	3.01463E-01	3.15578E-01
300.	3.17220E-01	3.42005E-03	2.97332E-01	3.37107E-01	3.09935E-01	3.24504E-01
310.	3.25633E-01	3.57645E-03	3.05621E-01	3.45645E-01	3.18015E-01	3.33251E-01
320.	3.33761E-01	3.79311E-03	3.13569E-01	3.53953E-01	3.25681E-01	3.41840E-01
330.	3.41602E-01	4.07777E-03	3.21160E-01	3.62045E-01	3.32917E-01	3.50288E-01
340.	3.49158E-01	4.43497E-03	3.28381E-01	3.69935E-01	3.39712E-01	3.58605E-01
350.	3.56429E-01	4.86638E-03	3.35218E-01	3.77639E-01	3.46063E-01	3.66794E-01
360.	3.63413E-01	5.37147E-03	3.41657E-01	3.85170E-01	3.51972E-01	3.74854E-01
370.	3.70112E-01	5.94847E-03	3.47685E-01	3.92539E-01	3.57442E-01	3.82782E-01
380.	3.76525E-01	6.59422E-03	3.53292E-01	3.99758E-01	3.62477E-01	3.90572E-01
390.	3.82653E-01	7.30826E-03	3.58470E-01	4.06834E-01	3.67085E-01	3.98218E-01
400.	3.88493E-01	8.08611E-03	3.63213E-01	4.13773E-01	3.71270E-01	4.05717E-01

Table F-40

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P8 WITH ICE-WATER BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
2.745398D 02	2.866099E-01	3.049925E-01	-1.827252E-02	1
2.764900D 02	3.135000E-01	3.057552E-01	7.744789E-03	1
2.790398D 02	2.976700E-01	3.074523E-01	-1.879238E-02	2
2.792698D 02	3.383800E-01	3.065561E-01	3.182387E-02	1
2.856299D 02	3.183700E-01	3.098204E-01	8.549631E-03	2
2.874833D 02	2.909900E-01	3.108647E-01	-1.987475E-02	3
2.921699D 02	3.466300E-01	3.129551E-01	3.397489E-02	2
3.051199D 02	2.986100E-01	3.191465E-01	-2.053654E-02	4
3.097998D 02	3.304000E-01	3.214386E-01	8.961380E-03	3
3.135000D 02	3.009300E-01	3.232713E-01	-2.234137E-02	5
3.219999D 02	3.005900E-01	3.274990E-01	-2.744007E-02	6
3.294700D 02	3.675700E-01	3.313301E-01	3.619091E-02	3
3.528338D 02	3.446800E-01	3.438762E-01	8.037090E-04	4
3.734900D 02	3.494900E-01	3.555356E-01	-6.015420E-03	5
3.938499D 02	3.557900E-01	3.675347E-01	-1.174474E-02	6
3.949500D 02	3.847499E-01	3.681999E-01	1.655000E-02	4
4.261699D 02	3.924600E-01	3.877471E-01	4.712990E-03	5
4.560798D 02	4.023999E-01	4.076931E-01	-4.283130E-03	6

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = 2.32213E-01

C_2 = 8.31626E-05

C_3 = 6.61229E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.150149E-02

d.f. = 15

t_α = 2.13

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
270.	3.02870E-01	1.31908E-02	2.52189E-01	3.53552E-01	2.81164E-01	3.24577E-01
280.	3.07339E-01	7.88211E-03	2.58560E-01	3.56117E-01	2.90550E-01	3.24127E-01
290.	3.11939E-01	6.41655E-03	2.64145E-01	3.59733E-01	2.98272E-01	3.25607E-01
300.	3.16672E-01	5.91103E-03	2.69175E-01	3.64169E-01	3.04082E-01	3.29263E-01
310.	3.21537E-01	6.18722E-03	2.73881E-01	3.69194E-01	3.08358E-01	3.34716E-01
320.	3.26535E-01	6.94742E-03	2.78470E-01	3.74599E-01	3.11950E-01	3.41120E-01
330.	3.31664E-01	7.57147E-03	2.83110E-01	3.80219E-01	3.15537E-01	3.47791E-01
340.	3.36926E-01	8.18724E-03	2.87920E-01	3.85932E-01	3.19487E-01	3.54365E-01
350.	3.42320E-01	8.61932E-03	2.92979E-01	3.91661E-01	3.23961E-01	3.60679E-01
360.	3.47847E-01	8.84783E-03	2.98322E-01	3.97371E-01	3.29001E-01	3.66693E-01
370.	3.53505E-01	8.90233E-03	3.03945E-01	4.03065E-01	3.34565E-01	3.72446E-01
380.	3.59296E-01	8.80386E-03	3.09809E-01	4.08785E-01	3.40544E-01	3.78048E-01
390.	3.65219E-01	8.69243E-03	3.15828E-01	4.14610E-01	3.46726E-01	3.83713E-01
400.	3.71276E-01	8.67046E-03	3.21896E-01	4.20663E-01	3.52787E-01	3.89762E-01
410.	3.77462E-01	8.99436E-03	3.27819E-01	4.27106E-01	3.58304E-01	3.96620E-01
420.	3.83782E-01	9.81755E-03	3.33436E-01	4.34128E-01	3.62871E-01	4.04693E-01
430.	3.90234E-01	1.12683E-02	3.38528E-01	4.41940E-01	3.66232E-01	4.14735E-01
440.	3.96819E-01	1.32796E-02	3.42877E-01	4.50759E-01	3.68320E-01	4.25317E-01
450.	4.03535E-01	1.60980E-02	3.45323E-01	4.60747E-01	3.69246E-01	4.37823E-01
460.	4.10384E-01	1.93794E-02	3.48729E-01	4.72039E-01	3.69105E-01	4.51667E-01

Table F-41

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P10 WITH BOILING-WATER BATH.

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
3.744299D 02	3.396000E-01	3.662902E-01	-2.669019E-02	1
3.904399D 02	4.049100E-01	3.760573E-01	2.885264E-02	1
3.820999D 02	3.382600E-01	3.786284E-01	-4.036838E-02	2
3.855898D 02	4.616300E-01	3.838574E-01	7.777262E-02	1
3.940198D 02	3.507000E-01	3.954904E-01	-4.479045E-02	3
4.008999D 02	3.997000E-01	4.039416E-01	-4.241645E-03	2
4.171399D 02	4.545200E-01	4.201691E-01	3.435087E-02	2
4.308398D 02	3.989800E-01	4.297963E-01	-3.081638E-02	3
4.636199D 02	4.436700E-01	4.377347E-01	5.935311E-03	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -1.65345E-00$

$C_2 = 9.10369E-03$

$C_3 = -9.90711E-06$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 4.727940E-02$

d.f. = 6

$t_\alpha = 2.45$

$\alpha = 0.05$

Temperature (°K)	k (W/cm-°K)	$s_{\overline{K}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
370.	3.58633E-01	3.75888E-02	2.10651E-01	5.06615E-01	2.66541E-01	4.50725E-01
380.	3.75366E-01	2.27221E-02	2.46849E-01	5.03883E-01	3.19697E-01	4.31035E-01
390.	3.90119E-01	1.80458E-02	2.66133E-01	5.14104E-01	3.45906E-01	4.34331E-01
400.	4.02890E-01	2.14807E-02	2.75661E-01	5.30120E-01	3.50262E-01	4.55518E-01
410.	4.13679E-01	2.57773E-02	2.81747E-01	5.45611E-01	3.50525E-01	4.76834E-01
420.	4.22487E-01	2.79321E-02	2.87948E-01	5.57026E-01	3.54054E-01	4.90921E-01
430.	4.29314E-01	2.82218E-02	2.94412E-01	5.64215E-01	3.60170E-01	4.98457E-01
440.	4.34158E-01	2.82260E-02	2.99251E-01	5.69065E-01	3.65005E-01	5.03312E-01
450.	4.37022E-01	3.13863E-02	2.97987E-01	5.76057E-01	3.60126E-01	5.13919E-01
460.	4.37904E-01	4.07200E-02	2.85030E-01	5.99778E-01	3.38140E-01	5.37668E-01

Table F-42

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUNS P7, P8, AND P10

Input Data		Calculated Data		Run No.
Temperature (^oK)	Thermal Cond ($W/cm-^oK$)	Thermal Cond ($W/cm-^oK$)	Residuals (input-calc)	
8.300999D 01	6.937796E-02	8.050483E-02	-1.112688E-02	1
8.946999D 01	8.762699E-02	8.972120E-02	-2.094209E-03	1
9.553999D 01	1.048500E-01	9.827685E-02	6.573141E-03	1
9.806999D 01	9.005398E-02	1.018130E-01	-1.175898E-02	2
1.239600D 02	1.403400E-01	1.369897E-01	3.350317E-03	2
1.251900D 02	1.278600E-01	1.386151E-01	-1.075512E-02	3
1.422700D 02	1.834900E-01	1.607569E-01	2.273309E-02	2
1.468300D 02	1.561100E-01	1.665329E-01	-1.042289E-02	4
1.750900D 02	2.047600E-01	2.010562E-01	3.703773E-03	3
2.098400D 02	2.714400E-01	2.405033E-01	3.093672E-02	3
2.151600D 02	2.456500E-01	2.462499E-01	-5.998611E-04	4
2.631199D 02	3.217900E-01	2.945491E-01	2.724087E-02	4
2.745398D 02	2.866099E-01	3.051195E-01	-1.850951E-02	5
2.764900D 02	3.135000E-01	3.068888E-01	6.611228E-03	5
2.780398D 02	2.876700E-01	3.082873E-01	-2.061737E-02	6
2.782698D 02	3.383800E-01	3.084943E-01	2.988565E-02	5
2.854299D 02	3.183700E-01	3.148659E-01	3.504038E-03	6
2.876899D 02	2.909999E-01	3.168479E-01	-2.584791E-02	7
2.921699D 02	3.469300E-01	3.207350E-01	2.619493E-02	6
3.051199D 02	2.986100E-01	3.316619E-01	-3.305191E-02	8
3.097998D 02	3.304000E-01	3.354976E-01	-5.097568E-03	7
3.294700D 02	3.675700E-01	3.509616E-01	1.660842E-02	7
3.528398D 02	3.446800E-01	3.679541E-01	-2.327418E-02	8
3.744299D 02	3.396000E-01	3.823206E-01	-4.272062E-02	9
3.804399D 02	4.049100E-01	3.860927E-01	1.881778E-02	9
3.820999D 02	3.382600E-01	3.871164E-01	-4.885638E-02	10
3.855898D 02	4.616300E-01	3.892451E-01	7.238489E-02	9
3.940198D 02	3.507000E-01	3.942491E-01	-4.354912E-02	11
3.949500D 02	3.847499E-01	3.947893E-01	-1.003939E-02	8
4.008999D 02	3.997000E-01	3.981887E-01	1.511335E-03	10
4.171399D 02	4.545200E-01	4.069722E-01	4.754776E-02	10
4.308398D 02	3.989800E-01	4.138194E-01	-1.483941E-02	11
4.636199D 02	4.436700E-01	4.281116E-01	1.555842E-02	11

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = -4.81155E-02

C_2 = 1.66336E-03

C_3 = -1.37217E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.27060E-02

d.f. = 30

t_α = 2.04

α = 0.05

Temperature (^oK)	k ($W/cm-^oK$)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	7.61713E-02	1.25341E-02	1.49444E-02	1.37398E-01	5.06016E-02	1.01741E-01
100.	1.04499E-01	1.02699E-02	4.50525E-02	1.63945E-01	8.35480E-02	1.25449E-01
120.	1.31729E-01	8.56196E-03	7.34189E-02	1.90038E-01	1.14262E-01	1.49195E-01
140.	1.57860E-01	7.45136E-03	1.00189E-01	2.15532E-01	1.42659E-01	1.73061E-01
160.	1.82894E-01	6.90739E-03	1.25506E-01	2.40283E-01	1.68803E-01	1.96985E-01
180.	2.06831E-01	6.79346E-03	1.49499E-01	2.64163E-01	1.92972E-01	2.20689E-01
200.	2.29670E-01	6.91373E-03	1.72277E-01	2.87062E-01	2.15566E-01	2.43773E-01
220.	2.51410E-01	7.09216E-03	1.93928E-01	3.08893E-01	2.36942E-01	2.65878E-01
240.	2.72054E-01	7.20923E-03	2.14511E-01	3.29597E-01	2.57347E-01	2.86761E-01
260.	2.91599E-01	7.19925E-03	2.34061E-01	3.49137E-01	2.76913E-01	3.06286E-01
280.	3.10047E-01	7.03960E-03	2.52591E-01	3.67503E-01	2.95686E-01	3.24408E-01
300.	3.27397E-01	6.74722E-03	2.70087E-01	3.84706E-01	3.13632E-01	3.41161E-01
320.	3.43649E-01	6.38683E-03	2.86512E-01	4.00786E-01	3.30620E-01	3.56678E-01
340.	3.58804E-01	6.09049E-03	3.01801E-01	4.15806E-01	3.46379E-01	3.71228E-01
360.	3.72860E-01	6.07053E-03	3.15867E-01	4.29854E-01	3.60477E-01	3.85244E-01
380.	3.85819E-01	6.56996E-03	3.28596E-01	4.43043E-01	3.72417E-01	3.99222E-01
400.	3.97681E-01	7.73441E-03	3.39854E-01	4.55507E-01	3.81902E-01	4.13459E-01
420.	4.08444E-01	9.55448E-03	3.49497E-01	4.67392E-01	3.88953E-01	4.27935E-01
440.	4.18110E-01	1.19463E-02	3.57374E-01	4.78846E-01	3.93740E-01	4.42480E-01
460.	4.26678E-01	1.48301E-02	3.63352E-01	4.90004E-01	3.96425E-01	4.56932E-01

Table F-43

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P11 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
8.093999D 01	7.925999E-02	9.049088E-02	-1.123089E-02	1
8.717000D 01	1.082300E-01	1.016005E-01	6.629527E-03	1
9.200000D 01	1.332099E-01	1.102125E-01	2.299744E-02	1
9.446999D 01	9.943998E-02	1.146163E-01	-1.517630E-02	2
1.167500D 02	1.658400E-01	1.543300E-01	1.150995E-02	2
1.182600D 02	1.380100E-01	1.570209E-01	-1.901096E-02	3
1.318600D 02	2.221600E-01	1.812536E-01	4.090643E-02	2
1.373900D 02	1.665699E-01	1.911051E-01	-2.453518E-02	4
1.458400D 02	1.771100E-01	2.061566E-01	-2.904660E-02	5
1.621700D 02	2.418800E-01	2.352371E-01	6.642878E-03	3
1.912500D 02	3.280500E-01	2.870001E-01	4.104984E-02	3
1.976500D 02	2.842500E-01	2.983882E-01	-1.413828E-02	4
2.134000D 02	2.988000E-01	3.264078E-01	-2.760786E-02	5
2.378600D 02	3.854300E-01	3.699056E-01	1.552439E-02	4
2.587698D 02	4.025600E-01	4.070735E-01	-4.513502E-03	5

Least Squares Fit Coefficients

$$k = C_1 + C_2 T + C_3 T^2$$

C_1 = -5.39659E-02

C_2 = 1.78614E-03

C_3 = -1.73274E-08

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.499143E-02

d.f. = 12

t_α = 2.18

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	8.88146E-02	1.41728E-02	2.61822E-02	1.51447E-01	5.79179E-02	1.19711E-01
90.	1.06647E-01	1.11737E-02	4.69678E-02	1.66325E-01	8.22878E-02	1.31005E-01
100.	1.24475E-01	9.09969E-03	6.64946E-02	1.82455E-01	1.04638E-01	1.44312E-01
110.	1.42300E-01	8.06828E-03	8.50499E-02	1.99550E-01	1.24711E-01	1.59889E-01
120.	1.60122E-01	7.96784E-03	1.02938E-01	2.17305E-01	1.42752E-01	1.77491E-01
130.	1.77940E-01	8.43256E-03	1.20441E-01	2.35439E-01	1.59557E-01	1.96323E-01
140.	1.95754E-01	9.08190E-03	1.37787E-01	2.53722E-01	1.75956E-01	2.15553E-01
150.	2.13566E-01	9.67001E-03	1.55148E-01	2.71983E-01	1.92485E-01	2.34646E-01
160.	2.31373E-01	1.00739E-02	1.72632E-01	2.90114E-01	2.09412E-01	2.53334E-01
170.	2.49178E-01	1.02496E-02	1.90292E-01	3.08063E-01	2.26833E-01	2.71522E-01
180.	2.66978E-01	1.02120E-02	2.08124E-01	3.25832E-01	2.44716E-01	2.89240E-01
190.	2.84776E-01	1.00300E-02	2.26070E-01	3.43481E-01	2.62910E-01	3.06641E-01
200.	3.02569E-01	9.83918E-03	2.44018E-01	3.61121E-01	2.81120E-01	3.24019E-01
210.	3.20360E-01	9.85482E-03	2.61796E-01	3.78924E-01	2.98876E-01	3.41843E-01
220.	3.38147E-01	1.03484E-02	2.79179E-01	3.97114E-01	3.15587E-01	3.60706E-01
230.	3.55930E-01	1.15628E-02	2.95900E-01	4.15960E-01	3.30723E-01	3.81137E-01
240.	3.73710E-01	1.36115E-02	3.11672E-01	4.35748E-01	3.44037E-01	4.03383E-01
250.	3.91487E-01	1.64788E-02	3.26228E-01	4.56746E-01	3.55563E-01	4.27411E-01
260.	4.09260E-01	2.00904E-02	3.39357E-01	4.79163E-01	3.65463E-01	4.53057E-01

Table F-44

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P12 WITH LN_2 BATH

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.081999D 01	7.984996E-02	8.941169E-02	-9.561718E-03	1
8.700999D 01	1.085800E-01	1.014909E-01	7.089138E-03	1
9.181999D 01	1.334900E-01	1.108266E-01	2.266335E-02	1
9.442999D 01	9.919000E-02	1.158740E-01	-1.668400E-02	2
1.169000D 02	1.654600E-01	1.586013E-01	6.858647E-03	2
1.182200D 02	1.379400E-01	1.612813E-01	-2.334137E-02	3
1.319700D 02	2.216000E-01	1.870337E-01	3.456634E-02	2
1.449100D 02	1.798699E-01	2.109396E-01	-3.106970E-02	4
1.621100D 02	2.412900E-01	2.422216E-01	-9.316206E-04	3
1.911900D 02	3.271300E-01	2.938271E-01	3.330294E-02	3
2.116[illegible]00D 02	3.025900E-01	3.291352E-01	-2.654523E-02	4
2.565098D 02	4.076200E-01	4.038661E-01	3.753901E-03	4

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = -7.50037E-02

C_2 = 2.11138E-03

C_3 = -9.53234E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.476342E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$s_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	8.78061E-02	1.42297E-02	2.32591E-02	1.52353E-01	5.56470E-02	1.19965E-01
90.	1.07299E-01	1.11359E-02	4.59366E-02	1.68662E-01	8.21342E-02	1.32464E-01
100.	1.26602E-01	9.14682E-03	6.69410E-02	1.86263E-01	1.05930E-01	1.47274E-01
110.	1.45714E-01	8.38387E-03	8.65283E-02	2.04800E-01	1.26767E-01	1.64662E-01
120.	1.64635E-01	8.62064E-03	1.05376E-01	2.23895E-01	1.45153E-01	1.84118E-01
130.	1.83366E-01	9.37356E-03	1.23525E-01	2.43207E-01	1.62182E-01	2.04550E-01
140.	2.01906E-01	1.02338E-02	1.41350E-01	2.62462E-01	1.78778E-01	2.25035E-01
150.	2.20256E-01	1.09719E-02	1.59043E-01	2.81468E-01	1.95459E-01	2.45052E-01
160.	2.38415E-01	1.14874E-02	1.76721E-01	3.00108E-01	2.12453E-01	2.64376E-01
170.	2.56383E-01	1.17583E-02	1.94429E-01	3.18336E-01	2.29809E-01	2.82956E-01
180.	2.74160E-01	1.18228E-02	2.12144E-01	3.36177E-01	2.47441E-01	3.00880E-01
190.	2.91747E-01	1.17755E-02	2.29774E-01	3.53718E-01	2.65134E-01	3.18360E-01
200.	3.09143E-01	1.17782E-02	2.47170E-01	3.71116E-01	2.82524E-01	3.35762E-01
210.	3.26349E-01	1.20618E-02	2.64098E-01	3.88600E-01	2.99089E-01	3.53608E-01
220.	3.43364E-01	1.28874E-02	2.80273E-01	4.06454E-01	3.14238E-01	3.72489E-01
230.	3.60188E-01	1.44704E-02	2.95368E-01	4.25008E-01	3.27485E-01	3.92891E-01
240.	3.76822E-01	1.69084E-02	3.09055E-01	4.44588E-01	3.38609E-01	4.15034E-01
250.	3.93265E-01	2.01936E-02	3.21050E-01	4.65479E-01	3.47627E-01	4.38902E-01
260.	4.09517E-01	2.42677E-02	3.31158E-01	4.87876E-01	3.54672E-01	4.64362E-01

Table F-45

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P13 WITH LN_2 BATH

Input Data: Temperature (°K)	Input Data: Thermal Cond (W/cm-°K)	Calculated Data: Thermal Cond (W/cm-°K)	Calculated Data: Residuals (input-calc)	Run No.
8.087000D 01	7.995999E-02	8.926338E-02	-9.303391E-03	1
8.703999D 01	1.087400E-01	1.016589E-01	7.081091E-03	1
9.184000D 01	1.336000E-01	1.112342E-01	2.236575E-02	1
9.439000D 01	9.992999E-02	1.162971E-01	-1.636708E-02	2
1.166300D 02	1.666700E-01	1.597427E-01	6.927252E-03	2
1.177100D 02	1.386499E-01	1.618201E-01	-2.317011E-02	3
1.317200D 02	2.232600E-01	1.884956E-01	3.476441E-02	2
1.451100D 02	1.783100E-01	2.135183E-01	-3.520828E-02	4
1.610800D 02	2.436799E-01	2.427586E-01	9.213090E-04	3
1.897700D 02	3.303100E-01	2.936391E-01	3.667086E-02	3
2.118900D 02	3.023000E-01	3.314210E-01	-2.912098E-02	4
2.565999D 02	4.083800E-01	4.039399E-01	4.440069E-03	4

Least Squares Fit Coefficients

$$k = C_1 + C_2T + C_3T^2$$

C_1 = -8.22670E-02

C_2 = 2.22519E-03

C_3 = -1.28753E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.614312E-02

d.f. = 9

t_α = 2.26

α = 0.05

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	8.75077E-02	1.50205E-02	1.93466E-02	1.55649E-01	5.35613E-02	1.21454E-01
90.	1.07571E-01	1.17490E-02	4.27950E-02	1.72347E-01	8.10179E-02	1.34124E-01
100.	1.27376E-01	9.64454E-03	6.44006E-02	1.90352E-01	1.05580E-01	1.49173E-01
110.	1.46924E-01	8.83529E-03	8.45580E-02	2.09291E-01	1.26957E-01	1.66892E-01
120.	1.66215E-01	9.08557E-03	1.03665E-01	2.28765E-01	1.45682E-01	1.86748E-01
130.	1.85248E-01	9.88420E-03	1.22083E-01	2.48413E-01	1.62910E-01	2.07586E-01
140.	2.04023E-01	1.07986E-02	1.40098E-01	2.67949E-01	1.79619E-01	2.28428E-01
150.	2.22542E-01	1.15851E-02	1.57917E-01	2.87166E-01	1.96359E-01	2.48724E-01
160.	2.40802E-01	1.21375E-02	1.75661E-01	3.05943E-01	2.13371E-01	2.68233E-01
170.	2.58805E-01	1.24330E-02	1.93380E-01	3.24230E-01	2.30706E-01	2.86904E-01
180.	2.76551E-01	1.25101E-02	2.11051E-01	3.42050E-01	2.48278E-01	3.04823E-01
190.	2.94038E-01	1.24685E-02	2.28579E-01	3.59498E-01	2.65859E-01	3.22218E-01
200.	3.11269E-01	1.24786E-02	2.45800E-01	3.76738E-01	2.83067E-01	3.39471E-01
210.	3.28242E-01	1.27795E-02	2.62477E-01	3.94007E-01	2.99360E-01	3.57124E-01
220.	3.44957E-01	1.36461E-02	2.78309E-01	4.11605E-01	3.14117E-01	3.75798E-01
230.	3.61415E-01	1.52041E-02	2.92953E-01	4.29878E-01	3.26828E-01	3.96003E-01
240.	3.77616E-01	1.78599E-02	3.06061E-01	4.49171E-01	3.37253E-01	4.17979E-01
250.	3.93559E-01	2.13076E-02	3.17337E-01	4.69781E-01	3.45404E-01	4.41714E-01
260.	4.09244E-01	2.55870E-02	3.26572E-01	4.91917E-01	3.51418E-01	4.67071E-01

Table F-46

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P14 WITH BOILING-WATER BATH

Input Data		Calculated Data		Run No.
Temperature (^oK)	Thermal Cond (W/cm-^oK)	Thermal Cond (W/cm-^oK)	Residuals (input-calc)	
4.081799D 02	2.876400E-01	2.877137E-01	-7.373095E-05	1
4.131199D 02	2.900299E-01	2.896206E-01	4.093051E-04	2
4.541599D 02	3.058100E-01	3.048285E-01	9.815097E-04	1
4.652798D 02	3.054600E-01	3.087541E-01	-3.294170E-03	2
4.993899D 02	3.248200E-01	3.202776E-01	4.542410E-03	1
5.147598D 02	3.226500E-01	3.252144E-01	-2.564490E-03	2

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

C_1 = 7.34761E-02

C_2 = 6.62046E-04

C_3 = -3.36089E-07

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 3.614691E-03

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (^oK)	k (W/cm-^oK)	$s_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
400.	2.84520E-01	3.58967E-03	2.68320E-01	3.00720E-01	2.73105E-01	2.95935E-01
410.	2.88418E-01	2.57996E-03	2.74296E-01	3.02540E-01	2.80214E-01	2.96622E-01
420.	2.92249E-01	2.05929E-03	2.79021E-01	3.05477E-01	2.85704E-01	2.98794E-01
430.	2.96013E-01	2.01537E-03	2.82852E-01	3.09173E-01	2.89604E-01	3.02422E-01
440.	2.99709E-01	2.21893E-03	2.86222E-01	3.13197E-01	2.92653E-01	3.06765E-01
450.	3.03339E-01	2.38174E-03	2.89573E-01	3.17104E-01	2.95765E-01	3.10912E-01
460.	3.06901E-01	2.44405E-03	2.93025E-01	3.20776E-01	2.99129E-01	3.14673E-01
470.	3.10395E-01	2.38317E-03	2.96627E-01	3.24164E-01	3.02817E-01	3.17974E-01

Table F-47

THERMAL CONDUCTIVITY OF PO-3 GRAPHITE: IML RUN P15 WITH BOILING-WATER BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Thermal Cond (W/cm-°K)	Thermal Cond (W/cm-°K)	Residuals (input-calc)	
3.843198D 02	4.115400E-01	4.094557E-01	2.084315E-03	1
3.985698D 02	4.005100E-01	4.259027E-01	-2.539277E-02	2
4.006099D 02	4.476500E-01	4.279446E-01	1.970536E-02	1
4.029500D 02	4.162900E-01	4.301896E-01	-1.389962E-02	3
4.156699D 02	4.816999E-01	4.405890E-01	4.111099E-02	1
4.313398D 02	4.354800E-01	4.492087E-01	-1.372868E-02	2
4.392998D 02	4.306599E-01	4.518143E-01	-2.115434E-02	3
4.616799D 02	4.681399E-01	4.527439E-01	1.539606E-02	2
4.744900D 02	4.449100E-01	4.490283E-01	-4.118323E-03	3

Least Squares Fit Coefficients

$k = C_1 + C_2T + C_3T^2$

$C_1 = -1.47741E-00$

$C_2 = 8.53076E-03$

$C_3 = -9.42221E-06$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 2.520163E-02$

d.f. = 6

$t_\alpha = 2.45$

$\alpha' = 0.05$

Temperature (°K)	k (W/cm-°K)	$S_{\bar{k}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
380.	4.03713E-01	2.43773E-02	3.17810E-01	4.89616E-01	3.43989E-01	4.63438E-01
390.	4.16471E-01	1.54447E-02	3.44054E-01	4.88887E-01	3.78631E-01	4.54310E-01
400.	4.27342E-01	1.08557E-02	3.60114E-01	4.94571E-01	4.00746E-01	4.53939E-01
410.	4.36331E-01	1.09698E-02	3.68991E-01	5.03670E-01	4.09455E-01	4.63207E-01
420.	4.43433E-01	1.26549E-02	3.74342E-01	5.12524E-01	4.12428E-01	4.74437E-01
430.	4.48652E-01	1.35917E-02	3.78501E-01	5.18803E-01	4.15353E-01	4.81952E-01
440.	4.51986E-01	1.35037E-02	3.81937E-01	5.22035E-01	4.18902E-01	4.85070E-01
450.	4.53437E-01	1.29295E-02	3.84041E-01	5.22833E-01	4.21759E-01	4.85114E-01
460.	4.53002E-01	1.36665E-02	3.82764E-01	5.23240E-01	4.19519E-01	4.86485E-01
470.	4.50683E-01	1.81500E-02	3.74593E-01	5.26773E-01	4.06215E-01	4.95150E-01

Table F-48

EFFECTIVE LORENZ RATIO OF ALUMINUM: PREIRRADIATION

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.210	1.996	2.424	2.129	2.291
100	2.206	2.021	2.391	2.154	2.258
120	2.323	2.064	2.400	2.194	2.270
140	2.272	2.115	2.429	2.237	2.307
160	2.318	2.168	2.469	2.282	2.355
180	2.367	2.221	2.512	2.328	2.406
200	2.414	2.273	2.556	2.374	2.454
220	2.460	2.322	2.597	2.420	2.500
240	2.501	2.367	2.636	2.463	2.540
260	2.539	2.407	2.670	2.501	2.577

Table F-49

EFFECTIVE LORENZ RATIO OF ALUMINUM: POSTIRRADIATION

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.253	1.957	2.549	2.158	2.349
100	2.254	1.999	2.508	2.193	2.314
120	2.283	2.054	2.512	2.239	2.326
140	2.325	2.112	2.538	2.286	2.365
160	2.374	2.172	2.576	2.333	2.415
180	2.424	2.231	2.618	2.381	2.468
200	2.474	2.287	2.661	2.429	2.519
220	2.522	2.341	2.703	2.377	2.566
240	2.566	2.390	2.742	2.524	2.609
260	2.606	2.435	2.778	2.565	2.648

Table F-50

EFFECTIVE LORENZ RATIO OF ALUMINUM: POSTIRRADIATION-ANNEAL

Temp (°K)	Lorenz Ratio (10^{-8} W-ohm/°K^2)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.227	2.019	2.435	2.148	2.306
100	2.220	2.041	2.399	2.169	2.271
120	2.244	2.081	2.407	2.207	2.281
140	2.283	2.130	2.436	2.249	2.317
160	2.329	2.183	2.475	2.293	2.364
180	2.377	2.236	2.518	2.339	2.415
200	2.425	2.288	2.562	2.386	2.464
220	2.471	2.337	2.604	2.432	2.510
240	2.513	2.383	2.644	2.476	2.551
260	2.552	2.424	2.680	2.515	2.589

Table F-51

EFFECTIVE LORENZ RATIO OF NBS BERYLLIUM: PREIRRADIATION

Temp (^{o}K)	Lorenz Ratio (10^{-8} W-ohm/$^{o}K^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.922	2.749	3.095	2.850	2.993
90	2.836	2.683	2.990	2.788	2.884
100	2.789	2.646	2.933	2.750	2.829
120	2.773	2.635	2.911	2.729	2.817
140	2.809	2.669	2.950	2.757	2.861
150	2.831	2.688	2.974	2.777	2.885
160	2.848	2.703	2.994	2.793	2.904

Table F-52

EFFECTIVE LORENZ RATIO OF NBS BERYLLIUM: POSTIRRADIATION

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.724	2.512	2.937	2.629	2.820
90	2.692	2.477	2.907	2.564	2.819
100	2.675	2.505	2.845	2.619	2.731
110	2.671	2.506	2.835	2.607	2.734
120	2.677	2.516	2.838	2.608	2.747
130	2.692	2.534	2.850	2.620	2.764
140	2.713	2.558	2.868	2.641	2.785

Table F-53

EFFECTIVE LORENZ RATIO OF NBS BERYLLIUM: POSTIRRADIATION-ANNEAL

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.947	2.752	3.142	2.864	3.030
90	2.853	2.681	3.025	2.797	2.909
100	2.802	2.642	2.963	2.756	2.848
120	2.789	2.634	2.944	2.736	2.842
140	2.841	2.682	2.999	2.777	2.904
150	2.874	2.712	3.036	2.807	2.941
160	2.904	2.738	3.070	2.834	2.974

Table F-54

EFFECTIVE LORENZ RATIO OF WANL BERYLLIUM: PREIRRADIATION

Temp (°K)	Lorenz Ratio (10^{-8} W-ohm/°K^2)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.526	2.350	2.702	2.421	2.631
90	2.527	2.384	2.670	2.472	2.582
100	2.533	2.391	2.675	2.470	2.596
110	2.544	2.403	2.686	2.477	2.612
120	2.558	2.418	2.697	2.493	2.622
130	2.569	2.427	2.710	2.501	2.637
140	2.575	2.422	2.728	2.489	2.660

Table F-55

EFFECTIVE LORENZ RATIO OF WANL BERYLLIUM: POSTIRRADIATION

Temp (^{o}K)	Lorenz Ratio (10^{-8} W-ohm/^{o}K^{2})	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.585	2.459	2.711	2.510	2.660
90	2.573	2.470	2.676	2.532	2.613
100	2.570	2.468	2.672	2.523	2.617
110	2.575	2.475	2.676	2.526	2.625
120	2.584	2.486	2.683	2.538	2.631
130	2.592	2.493	2.692	2.544	2.641
140	2.595	2.487	2.703	2.532	2.658

Table F-56

EFFECTIVE LORENZ RATIO OF WANL BERYLLIUM: POSTIRRADIATION-ANNEAL

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	2.531	2.225	2.837	2.345	2.717
90	2.630	2.392	2.869	2.546	2.715
100	2.674	2.445	2.902	2.578	2.769
110	2.686	2.464	2.907	2.585	2.786
120	2.681	2.470	2.893	2.587	2.776
130	2.672	2.463	2.882	2.573	2.772
140	2.666	2.451	2.881	2.551	2.782

Table F-57

EFFECTIVE LORENZ RATIO OF TITANIUM: PREIRRADIATION

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	8.421	7.012	9.829	7.892	8.949
100	7.368	6.258	8.478	7.049	7.687
120	6.686	5.759	7.613	6.468	6.905
140	6.217	5.410	7.023	6.032	6.402
160	5.880	5.159	6.601	5.699	6.061
180	5.631	4.976	6.287	5.448	5.815
200	5.444	4.841	6.048	5.261	5.628
220	5.302	4.743	5.862	5.123	5.481
240	5.194	4.673	5.715	5.022	5.365
260	5.111	4.623	5.598	4.949	5.272
280	5.048	4.589	5.507	4.894	5.202
300	5.001	4.565	5.437	4.849	5.152

Table F-58

EFFECTIVE LORENZ RATIO OF TITANIUM: POSTIRRADIATION

Temp (°K)	Lorenz Ratio (10^{-8} W-ohm/°K^2)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	8.314	5.731	10.896	7.067	9.560
100	7.318	5.326	9.311	6.551	8.086
120	6.675	5.028	8.321	6.139	7.211
140	6.233	4.803	7.662	5.780	6.685
160	5.917	4.634	7.199	5.477	6.356
180	5.685	5.510	5.860	5.612	5.758
200	5.512	4.424	6.601	5.067	5.957
220	5.383	4.367	6.398	4.945	5.821
240	5.286	4.334	6.237	4.862	5.709
260	5.214	4.319	6.108	4.810	5.617
280	5.162	4.317	6.006	4.776	5.547
300	5.125	4.321	5.929	4.752	5.499

Table F-59

EFFECTIVE LORENZ RATIO OF TITANIUM: POSTIRRADIATION-ANNEAL

Temp (°K)	Lorenz Ratio (10^{-8} W-ohm/°K^2)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	8.197	4.588	11.805	6.488	9.906
100	7.293	4.494	10.092	6.235	8.351
120	6.706	4.386	9.027	5.964	7.449
140	6.300	4.283	8.318	5.672	6.929
160	6.007	4.196	7.817	5.396	6.617
180	5.787	4.129	7.445	5.169	6.404
200	5.618	4.082	7.154	4.998	6.238
220	5.486	4.054	6.918	4.875	6.097
240	5.381	4.042	6.721	4.790	5.972
260	5.297	4.040	6.554	4.733	5.862
280	5.228	4.044	6.413	4.690	5.767
300	5.172	4.048	6.296	4.650	5.694

Table F-60

EFFECTIVE LORENZ RATIO OF PO-3 GRAPHITE: PREIRRADIATION

Temp (°K)	Lorenz Ratio (10^{-8} W-ohm/°K^2)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	569.0	104.6	1033.5	357.4	780.7
100	651.8	310.9	992.7	526.0	777.6
120	681.5	416.1	946.9	601.7	761.2
140	683.3	467.2	899.4	625.8	740.8
160	669.7	488.1	851.3	621.8	717.7
180	647.5	491.4	803.6	604.0	691.0
200	620.7	484.5	756.9	580.4	661.0
220	591.6	471.4	711.8	554.6	628.6
240	561.8	454.9	668.7	528.4	595.1
260	532.1	436.4	627.9	502.5	561.8
280	503.3	416.8	589.8	476.9	529.7
290	489.3	406.8	571.8	464.2	514.4

Table F-61

EFFECTIVE LORENZ RATIO OF PO-3 GRAPHITE: POSTIRRADIATION

Temp (^{o}K)	Lorenz Ratio (10^{-8} W-ohm/$^{o}K^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	242.2	37.3	447.2	139.7	344.8
100	267.0	113.7	420.4	205.8	328.2
120	285.3	162.7	408.0	244.9	325.8
140	299.4	196.6	402.3	267.6	331.3
160	310.4	221.4	399.3	281.4	339.4
180	318.7	240.3	397.1	290.9	346.5
200	324.8	255.1	394.4	298.2	351.3
210	327.0	261.2	392.8	301.3	352.7
220	328.7	266.5	390.8	303.9	353.4
240	330.5	275.0	386.0	308.0	353.1
260	330.3	280.8	379.9	310.1	350.6
280	328.1	283.8	372.5	309.8	346.4
290	326.3	284.2	368.3	308.7	343.8

Table F-62

EFFECTIVE LORENZ RATIO FO PO-3 GRAPHITE: POSTIRRADIATION-ANNEAL

Temp (^oK)	Lorenz Ratio (10^{-8} W-ohm/$^oK^2$)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	224.6	86.0	363.2	158.6	290.6
100	269.1	165.5	372.7	230.1	308.1
120	296,8	213.9	379.8	271.0	322.6
140	315.0	245.3	384.6	294.4	335.5
160	327.1	266.8	387.5	308.3	346.0
180	335.3	281.9	388.6	317.2	353.3
200	340.6	293.0	388.3	323.4	357.8
220	343.9	301.1	386.8	328.0	359.9
240	345.7	307.0	384.4	331.2	360.3
260	346.3	311.2	381.5	333.2	359.5
280	346.0	313.8	378.2	333.8	358.3
290	345.6	314.6	376.6	333.5	357.7

Table F-63

ELECTRICAL RESISTIVITY OF ALUMINUM: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	2.038799E 00	2.023319E 00	1.548004E-02	0
8.926999D 01	2.160399E 00	2.166588E 00	-6.188393E-03	1
1.016400D 02	2.309600E 00	2.316069E 00	-6.468773E-03	2
1.258800D 02	2.604099E 00	2.609514E 00	-5.414963E-03	3
1.404000D 02	2.775800E 00	2.785625E 00	-9.824753E-03	4
1.886200D 02	3.379000E 00	3.372271E 00	6.729126E-03	5
2.139900D 02	3.691000E 00	3.682030E 00	8.970261E-03	6
2.191600D 02	3.752000E 00	3.745247E 00	6.752968E-03	7
2.289000D 02	3.865000E 00	3.864431E 00	5.683899E-04	8
2.450400D 02	4.059999E 00	4.062178E 00	-2.178192E-03	9
2.603799D 02	4.242000E 00	4.250407E 00	-8.407593E-03	10

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.09321E-00

C_2 = 1.19710E-02

C_3 = 5.92796E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 9.305403E-03

d.f. = 8

t_α = 2.31

α = 0.05

Temperature[1] (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.05469E 00	6.12848E-03	2.02895E 00	2.08042E 00	2.04053E 00	2.06884E 00
90.	2.17540E 00	4.96772E-03	2.15104E 00	2.19977E 00	2.16393E 00	2.18688E 00
100.	2.29624E 00	4.25689E-03	2.27260E 00	2.31988E 00	2.28641E 00	2.30607E 00
110.	2.41720E 00	4.00348E-03	2.39379E 00	2.44060E 00	2.40795E 00	2.42644E 00
120.	2.53827E 00	4.09839E-03	2.51478E 00	2.56176E 00	2.52880E 00	2.54774E 00
130.	2.65946E 00	4.36876E-03	2.63571E 00	2.68321E 00	2.64937E 00	2.66955E 00
140.	2.78077E 00	4.67010E-03	2.75672E 00	2.80482E 00	2.76998E 00	2.79156E 00
150.	2.90220E 00	4.91332E-03	2.87789E 00	2.92651E 00	2.89085E 00	2.91355E 00
160.	3.02275E 00	5.05066E-03	2.99929E 00	3.04820E 00	3.01208E 00	3.03541E 00
170.	3.14541E 00	5.05998E-03	3.12094E 00	3.16988E 00	3.13372E 00	3.15710E 00
180.	3.26720E 00	4.93653E-03	3.24286E 00	3.29153E 00	3.25579E 00	3.27860E 00
190.	3.38910E 00	4.69170E-03	3.36503E 00	3.41317E 00	3.37826E 00	3.39994E 00
200.	3.51112E 00	4.35813E-03	3.48738E 00	3.53486E 00	3.50105E 00	3.52119E 00
210.	3.63326E 00	4.00409E-03	3.60985E 00	3.65666E 00	3.62401E 00	3.64251E 00
220.	3.75552E 00	3.75613E-03	3.73234E 00	3.77870E 00	3.74684E 00	3.76420E 00
230.	3.87790E 00	3.80211E-03	3.85468E 00	3.90112E 00	3.86912E 00	3.88668E 00
240.	4.00039E 00	4.30924E-03	3.97671E 00	4.02408E 00	3.99044E 00	4.01035E 00
250.	4.12301E 00	5.31028E-03	4.09825E 00	4.14776E 00	4.11074E 00	4.13528E 00
260.	4.24574E 00	6.73457E-03	4.21921E 00	4.27228E 00	4.23018E 00	4.26130E 00

Table F-64

ELECTRICAL RESISTIVITY OF ALUMINUM: POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	2.186000E 00	2.192357E 00	-6.357193E-03	0
8.909999D 01	2.340799E 00	2.324313E 00	1.649617E-02	1
1.010000D 02	2.449599E 00	2.458866E 00	-9.266853E-03	2
1.234000D 02	2.713300E 00	2.713076E 00	2.241135E-04	3
1.416500D 02	2.919600E 00	2.921088E 00	-1.488686E-03	4
1.852200D 02	3.414000E 00	3.420967E 00	-6.967545E-03	5
2.101300D 02	3.709000E 00	3.708831E 00	1.688004E-04	6
2.150700D 02	3.775999E 00	3.766096E 00	9.902954E-03	7
2.238600D 02	3.867000E 00	3.868140E 00	-1.140594E-03	8
2.408900D 02	4.070999E 00	4.066376E 00	4.623413E-03	9
2.574800D 02	4.254000E 00	4.260166E 00	-6.166458E-03	10

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.32779E-00

C_2 = 1.10762E-02

C_3 = 1.21385E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 8.715600E-03

d.f. = 8

t_α = 2.31

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.22165E 00	5.70930E-03	2.19758E 00	2.24572E 00	2.20846E 00	2.23484E 00
90.	2.33448E 00	4.62444E-03	2.31169E 00	2.35727E 00	2.32379E 00	2.34516E 00
100.	2.44755E 00	3.96613E-03	2.42543E 00	2.46967E 00	2.43839E 00	2.45671E 00
110.	2.56086E 00	3.73659E-03	2.53895E 00	2.58276E 00	2.55223E 00	2.56949E 00
120.	2.67441E 00	3.82756E-03	2.65242E 00	2.69640E 00	2.66557E 00	2.68325E 00
130.	2.78821E 00	4.07476E-03	2.75599E 00	2.81043E 00	2.77880E 00	2.79762E 00
140.	2.90225E 00	4.34363E-03	2.87975E 00	2.92474E 00	2.89221E 00	2.91228E 00
150.	3.01653E 00	4.55238E-03	2.99382E 00	3.03925E 00	3.00602E 00	3.02705E 00
160.	3.13106E 00	4.65804E-03	3.10823E 00	3.15388E 00	3.12030E 00	3.14182E 00
170.	3.24582E 00	4.64185E-03	3.22301E 00	3.26863E 00	3.23510E 00	3.25655E 00
180.	3.36084E 00	4.50212E-03	3.33817E 00	3.38350E 00	3.35044E 00	3.37124E 00
190.	3.47609E 00	4.25467E-03	3.45368E 00	3.49849E 00	3.46626E 00	3.48592E 00
200.	3.59159E 00	3.93944E-03	3.56949E 00	3.61368E 00	3.58248E 00	3.60069E 00
210.	3.70732E 00	3.63752E-03	3.68551E 00	3.72914E 00	3.69892E 00	3.71573E 00
220.	3.82331E 00	3.49154E-03	3.80162E 00	3.84499E 00	3.81524E 00	3.83137E 00
230.	3.93953E 00	3.68578E-03	3.91767E 00	3.96139E 00	3.93102E 00	3.94804E 00
240.	4.05600E 00	4.34036E-03	4.03351E 00	4.07849E 00	4.04597E 00	4.06602E 00
250.	4.17271E 00	5.44228E-03	4.14897E 00	4.19644E 00	4.16014E 00	4.18528E 00
260.	4.28966E 00	6.91552E-03	4.26396E 00	4.31536E 00	4.27369E 00	4.30564E 00

Table F-65

ELECTRICAL RESISTIVITY OF ALUMINUM: POSTIRRADIATION-ANNEAL

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	2.040995E 00	2.028370E 00	1.262951E-02	0
8.925999D 01	2.161799E 00	2.171241E 00	-9.441376E-03	1
1.017900D 02	2.324200E 00	2.322428E 00	1.771927E-03	2
1.258600D 02	2.607599E 00	2.613567E 00	-5.968094E-03	3
1.402000D 02	2.777800E 00	2.787458E 00	-9.658813E-03	4
1.888600D 02	3.384000E 00	3.379993E 00	4.006386E-03	5
2.135200D 02	3.700000E 00	3.681733E 00	1.826668E-02	6
2.189900D 02	3.749000E 00	3.748797E 00	2.021790E-04	7
2.289000D 02	3.867000E 00	3.870418E 00	-3.417969E-03	8
2.442600D 02	4.056000E 00	4.059237E 00	-3.237724E-03	9
2.599199D 02	4.247000E 00	4.252134E 00	-5.134583E-03	10

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.10153E-00

C_2 = 1.19124E-02

C_3 = 8.04084E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 9.867791E-03

d.f. = 8

t_α = 2.31

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.05967E 00	6.50696E-03	2.03237E 00	2.08698E 00	2.04464E 00	2.07470E 00
90.	2.18016E 00	5.27034E-03	2.15432E 00	2.20600E 00	2.16799E 00	2.19234E 00
100.	2.30081E 00	4.51496E-03	2.27575E 00	2.32588E 00	2.29038E 00	2.31124E 00
110.	2.42163E 00	4.24855E-03	2.39681E 00	2.44645E 00	2.41181E 00	2.43144E 00
120.	2.54260E 00	4.35324E-03	2.51769E 00	2.56752E 00	2.53255E 00	2.55266E 00
130.	2.66374E 00	4.64334E-03	2.63854E 00	2.68893E 00	2.65301E 00	2.67446E 00
140.	2.78503E 00	4.96469E-03	2.75951E 00	2.81055E 00	2.77356E 00	2.79650E 00
150.	2.90649E 00	5.22247E-03	2.88070E 00	2.93228E 00	2.89442E 00	2.91855E 00
160.	3.02810E 00	5.36620E-03	3.00216E 00	3.05405E 00	3.01571E 00	3.04050E 00
170.	3.14988E 00	5.37271E-03	3.12393E 00	3.17584E 00	3.13747E 00	3.16229E 00
180.	3.27182E 00	5.23709E-03	3.24601E 00	3.29763E 00	3.25972E 00	3.28392E 00
190.	3.39392E 00	4.97202E-03	3.36840E 00	3.41945E 00	3.38244E 00	3.40541E 00
200.	3.51618E 00	4.61330E-03	3.49102E 00	3.54134E 00	3.50552E 00	3.52684E 00
210.	3.63860E 00	4.23545E-03	3.61380E 00	3.66341E 00	3.62882E 00	3.64839E 00
220.	3.76119E 00	3.97671E-03	3.73661E 00	3.78576E 00	3.75200E 00	3.77037E 00
230.	3.88393E 00	4.04088E-03	3.85930E 00	3.90856E 00	3.87459E 00	3.89326E 00
240.	4.00683E 00	4.60312E-03	3.98168E 00	4.03198E 00	3.99620E 00	4.01746E 00
250.	4.12990E 00	5.69259E-03	4.10358E 00	4.15621E 00	4.11675E 00	4.14305E 00
260.	4.25312E 00	7.23042E-03	4.22486E 00	4.28138E 00	4.23642E 00	4.26982E 00

Table F-66

ELECTRICAL RESISTIVITY OF ALUMINUM: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data: Fluence (10^{17} n/cm^2)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
0.0	2.037999E 00	2.045963E 00	-7.964134E-03	0
1.462999D 00	2.099799E 00	2.087509E 00	1.229000E-02	1
1.945999D 00	2.101000E 00	2.101226E 00	-2.260208E-04	2
4.094999D 00	2.158999E 00	2.162253E 00	-3.253937E-03	3
4.995999D 00	2.186999E 00	2.187840E 00	-8.411407E-04	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2\Phi$

C_1 = 2.04596E 00

C_2 = 2.83982E-19

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 8.675985E-03

d.f. = 3

t_α = 3.18

α = 0.05

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
0.0	2.04596E 00	6.61284E-03	2.01127E 00	2.08065E 00	2.02493E 00	2.06699E 00
1.000E-00	2.07436E 00	5.03762E-03	2.04246E 00	2.10626E 00	2.05834E 00	2.09038E 00
2.000E 00	2.10276E 00	4.02511E-03	2.07234E 00	2.13317E 00	2.08996E 00	2.11556E 00
3.000E 00	2.13116E 00	4.02511E-03	2.10074E 00	2.16157E 00	2.11836E 00	2.14396E 00
4.000E 00	2.15956E 00	5.03762E-03	2.12765E 00	2.19146E 00	2.14354E 00	2.17557E 00
5.000E 00	2.18795E 00	6.61284E-03	2.15326E 00	2.22264E 00	2.16692E 00	2.20898E 00

Table F-67

ELECTRICAL RESISTIVITY OF ALUMINUM: CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (°K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.16696	0.13462	0.19929	0.14920	0.18471
90	0.15908	0.12846	0.18969	0.14469	0.17346
100	0.15131	0.12160	0.18101	0.13897	0.16364
120	0.13614	0.10661	0.16566	0.12425	0.14802
140	0.12148	0.09130	0.15165	0.10806	0.13489
160	0.10731	0.07660	0.13801	0.09274	0.12187
180	0.09364	0.06313	0.12414	0.07948	0.10779
200	0.08047	0.05071	0.11022	0.06802	0.09291
220	0.06779	0.03865	0.09692	0.05692	0.07865
240	0.05561	0.02561	0.08560	0.04261	0.06860
250	0.04970	0.01820	0.08119	0.03353	0.06586
260	0.04392	0.00998	0.07785	0.02339	0.06444

Table F-68

ELECTRICAL RESISTIVITY OF NBS BERYLLIUM: PREIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	1.067200E 00	1.063840E 00	3.359795E-03	0
8.289999D 01	1.079499E 00	1.083917E 00	-4.417419E-03	1
9.829999D 01	1.165000E 00	1.164308E 00	6.923676E-04	2
1.170000D 02	1.310499E 00	1.309829E 00	6.704330E-04	3
1.395000D 02	1.552400E 00	1.554556E 00	-2.156258E-03	4
1.494200D 02	1.690000E 00	1.686612E 00	3.387451E-03	5
1.600500D 02	1.842999E 00	1.844531E 00	-1.531601E-03	6

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.26332E-00

C_2 = -8.39156E-03

C_3 = 7.51202E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.542623E-03

d.f. = 4

t_α = 2.78

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.07276E 00	2.40283E-03	1.06086E 00	1.08466E 00	1.06608E 00	1.07944E 00
85.	1.09278E 00	1.99715E-03	1.08148E 00	1.10409E 00	1.08723E 00	1.09833E 00
90.	1.11655E 00	1.84135E-03	1.10545E 00	1.12765E 00	1.11143E 00	1.12167E 00
95.	1.14408E 00	1.88497E-03	1.13293E 00	1.15524E 00	1.13884E 00	1.14932E 00
100.	1.17537E 00	2.03003E-03	1.16401E 00	1.18672E 00	1.16972E 00	1.18101E 00
105.	1.21041E 00	2.19260E-03	1.19882E 00	1.22199E 00	1.20431E 00	1.21650E 00
110.	1.24920E 00	2.32315E-03	1.23743E 00	1.26098E 00	1.24274E 00	1.25566E 00
115.	1.29176E 00	2.39680E-03	1.27986E 00	1.30365E 00	1.28509E 00	1.29842E 00
120.	1.33806E 00	2.40313E-03	1.32616E 00	1.34996E 00	1.33138E 00	1.34474E 00
125.	1.38813E 00	2.34093E-03	1.37632E 00	1.39993E 00	1.38162E 00	1.39464E 00
130.	1.44195E 00	2.21927E-03	1.43033E 00	1.45357E 00	1.43578E 00	1.44812E 00
135.	1.49953E 00	2.06097E-03	1.48813E 00	1.51092E 00	1.49380E 00	1.50525E 00
140.	1.56086E 00	1.90958E-03	1.54967E 00	1.57205E 00	1.55555E 00	1.56617E 00
145.	1.62595E 00	1.84356E-03	1.61484E 00	1.63705E 00	1.62082E 00	1.63107E 00
150.	1.69479E 00	1.96185E-03	1.68353E 00	1.70605E 00	1.68934E 00	1.70024E 00
155.	1.76739E 00	2.32680E-03	1.75561E 00	1.77917E 00	1.76092E 00	1.77386E 00
160.	1.84375E 00	2.92796E-03	1.83097E 00	1.85653E 00	1.83561E 00	1.85189E 00

Table F-69

ELECTRICAL RESISTIVITY OF NBS BERYLLIUM: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^oK)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.842500E 00	1.837568E 00	4.931450E-03	0
8.281999D 01	1.852599E 00	1.858556E 00	-5.956650E-03	1
9.714000D 01	1.933599E 00	1.934351E 00	-7.514954E-04	2
1.160000D 02	2.081900E 00	2.079217E 00	2.682686E-03	3
1.400000D 02	2.336699E 00	2.337598E 00	-8.983612E-04	4

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.99923E-00

C_2 = -7.65937E-03

C_3 = 7.19736E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.846769E-03

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$s_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.84711E 00	4.01456E-03	1.81661E 00	1.87760E 00	1.82984E 00	1.86437E 00
85.	1.86819E 00	3.30055E-03	1.83932E 00	1.89706E 00	1.85400E 00	1.88238E 00
90.	1.89287E 00	3.31606E-03	1.86397E 00	1.92177E 00	1.87861E 00	1.90713E 00
95.	1.92115E 00	3.70843E-03	1.89138E 00	1.95092E 00	1.90520E 00	1.93709E 00
100.	1.95303E 00	4.13798E-03	1.92222E 00	1.98383E 00	1.93523E 00	1.97082E 00
105.	1.98850E 00	4.44039E-03	1.95693E 00	2.02007E 00	1.96941E 00	2.00760E 00
110.	2.02758E 00	4.55759E-03	1.99570E 00	2.05945E 00	2.00798E 00	2.04717E 00
115.	2.07025E 00	4.49166E-03	2.03855E 00	2.10195E 00	2.05093E 00	2.08956E 00
120.	2.11652E 00	4.29551E-03	2.08532E 00	2.14772E 00	2.09805E 00	2.13499E 00
125.	2.16639E 00	4.09371E-03	2.13570E 00	2.19708E 00	2.14879E 00	2.18400E 00
130.	2.21986E 00	4.11066E-03	2.18913E 00	2.25060E 00	2.20219E 00	2.23754E 00
135.	2.27693E 00	4.61718E-03	2.24489E 00	2.30897E 00	2.25708E 00	2.29678E 00
140.	2.33760E 00	5.75279E-03	2.30233E 00	2.37287E 00	2.31286E 00	2.36233E 00

Table F-70

ELECTRICAL RESISTIVITY OF NBS BERYLLIUM: POSTIRRADIATION-ANNEAL

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.070700E 00	1.072556E 00	-1.855850F-03	0
8.303000D 01	1.089000E 00	1.089603E 00	-6.036758E-04	1
9.843999D 01	1.168300E 00	1.162925E 00	5.374908E-03	2
1.171000D 02	1.302500E 00	1.303984E 00	-1.483917E-03	3
1.384000D 02	1.532000E 00	1.534986E 00	-2.986908E-03	4
1.617800D 02	1.875999E 00	1.874440E 00	1.559258E-03	5

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.36661E-00

C_2 = -1.01633E-02

C_3 = 8.22251E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.926538E-03

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.07978E 00	2.66888E-03	1.06468E 00	1.09488E 00	1.07129E 00	1.08827E 00
85.	1.09680E 00	2.21888E-03	1.08246E 00	1.11114E 00	1.08974E 00	1.10386E 00
90.	1.11793E 00	2.02915E-03	1.10387E 00	1.13198E 00	1.11148E 00	1.12438E 00
95.	1.14317E 00	2.05612E-03	1.12908E 00	1.15727E 00	1.13663E 00	1.14971E 00
100.	1.17252E 00	2.20306E-03	1.15821E 00	1.18684E 00	1.16552E 00	1.17953E 00
105.	1.20599E 00	2.38157E-03	1.19138E 00	1.27059E 00	1.19841E 00	1.21356E 00
110.	1.24356E 00	2.53715E-03	1.22870E 00	1.25843E 00	1.23550E 00	1.25163E 00
115.	1.28525E 00	2.64169E-03	1.27020E 00	1.30030E 00	1.27685E 00	1.29365E 00
120.	1.33105E 00	2.68441E-03	1.31592E 00	1.34617E 00	1.32251E 00	1.33958E 00
125.	1.38096E 00	2.66530E-03	1.36587E 00	1.39605E 00	1.37248E 00	1.38943F 00
130.	1.43498E 00	2.59536E-03	1.42001E 00	1.44994E 00	1.42672E 00	1.44323E 00
135.	1.49311E 00	2.49836E-03	1.47831E 00	1.50791E 00	1.48516E 00	1.50105E 00
140.	1.55535E CC	2.41591E-03	1.54069E 00	1.57001E 00	1.54767E 00	1.56303E 00
145.	1.62171E 00	2.41124E-03	1.60705E 00	1.63636E 00	1.61404E 00	1.62937E 00
150.	1.69217E 00	2.55873E-03	1.67727E 00	1.70708E 00	1.68404E 00	1.70031E 00
155.	1.76675E 00	2.91271E-03	1.75120E 00	1.78229E 00	1.75748E 00	1.77601E 00
160.	1.84544E 00	3.48538E-03	1.82874E 00	1.86213E 00	1.83435E 00	1.85652E 00

Table F-71

ELECTRICAL RESISTIVITY OF NBS BERYLLIUM: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data: Fluence (10^{17} n/cm^2)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
0.0	1.066000E 00	1.043020E 00	2.297974E-02	0
3.221999D 00	1.254999E 00	1.273067E 00	-1.806736E-02	1
4.287000D 00	1.332999E 00	1.349106E 00	-1.610661E-02	2
9.020000D 00	1.684999E 00	1.687036E 00	-2.036095E-03	3
1.100500D 01	1.841999E 00	1.828762E 00	1.323700E-02	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

$C_1 = 1.04302\text{E } 00$

$C_2 = 7.13987\text{E-}19$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 2.076282\text{E-}02$

d.f. = 3

$t_\alpha = 3.18$

$\alpha = 0.05$

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
0.0	1.04302E 00	1.58253E-02	9.60003E-01	1.12604E 00	9.92696E-01	1.09334E 00
1.000E 00	1.11442E 00	1.40076E-02	1.03477E 00	1.19406E 00	1.06987E 00	1.15896E 00
2.000E 00	1.18582E 00	1.23618E-02	1.10897E 00	1.26266E 00	1.14651E 00	1.22513E 00
3.000E 00	1.25722E 00	1.09658E-02	1.18255E 00	1.33188E 00	1.22234E 00	1.29209E 00
4.000E 00	1.32861E 00	9.92543E-03	1.25543E 00	1.40180E 00	1.29705E 00	1.36018E 00
5.000E 00	1.40001E 00	9.36001E-03	1.32759E 00	1.47244E 00	1.37025E 00	1.42978E 00
6.000E 00	1.47141E 00	9.35608E-03	1.39899E 00	1.54383E 00	1.44166E 00	1.50116E 00
7.000E 00	1.54281E 00	9.91430E-03	1.46964E 00	1.61598E 00	1.51128E 00	1.57434E 00
8.000E 00	1.61421E 00	1.09490E-02	1.53957E 00	1.68885E 00	1.57939E 00	1.64903E 00
9.000E 00	1.68561E 00	1.23410E-02	1.60880E 00	1.76242E 00	1.64636E 00	1.72485E 00
1.000E 01	1.75701E 00	1.39839E-02	1.67740E 00	1.83661E 00	1.71254E 00	1.80147E 00
1.100E 01	1.82841E 00	1.57996E-02	1.74544E 00	1.91137E 00	1.77816E 00	1.87865E 00

Table F-72

ELECTRICAL RESISTIVITY OF NBS BERYLLIUM:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (°K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.77435	0.75572	0.79297	0.76385	0.78484
90	0.77632	0.75880	0.79383	0.76795	0.78468
100	0.77766	0.75936	0.79595	0.76775	0.78756
110	0.77838	0.75942	0.79733	0.76729	0.78946
120	0.77846	0.75962	0.79729	0.76758	0.78933
130	0.77791	0.70763	0.84818	0.70934	0.84647
140	0.77674	0.75710	0.79637	0.76453	0.78894

Table F-73

ELECTRICAL RESISTIVITY OF WANL BERYLLIUM: PREIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.7399990 01	6.788999E-01	6.796576E-01	-7.576942E-04	0
8.7969990 01	7.120000E-01	7.136934E-01	-1.693487E-03	1
9.9299990 01	7.740000E-01	7.685375E-01	5.462468E-03	2
1.237600D 02	9.460000E-01	9.517179E-01	-5.717933E-03	3
1.377500D 02	1.099000E 00	1.096292E 00	2.707481E-03	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2 T + C_3 T^2$

C_1 = 9.34264E-01

C_2 = -9.01688E-03

C_3 = 7.39974E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2 / \text{d.f.}}$

s_e = 6.054159E-03

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	6.86497E-01	4.61430E-03	6.53764E-01	7.19229E-01	6.66655E-01	7.06338E-01
85.	7.02460E-01	3.65185E-03	6.72058E-01	7.32862E-01	6.86757E-01	7.18163E-01
90.	7.22123E-01	3.58622E-03	6.91866E-01	7.52381E-01	7.06703E-01	7.37544E-01
95.	7.45486E-01	4.00661E-03	7.14269E-01	7.76704E-01	7.28258E-01	7.62715E-01
100.	7.72549E-01	4.47539E-03	7.40176E-01	8.04923E-01	7.53305E-01	7.91794E-01
105.	8.03312E-01	4.77991E-03	7.70144E-01	8.36481E-01	7.82759E-01	8.23866E-01
110.	8.37775E-01	4.84601E-03	8.04429E-01	8.71121E-01	8.16937E-01	8.58613E-01
115.	8.75939E-01	4.67485E-03	8.43048E-01	9.08829E-01	8.55837E-01	8.96040E-01
120.	9.17800E-01	4.33347E-03	8.85785E-01	9.49814E-01	8.99166E-01	9.36434E-01
125.	9.63363E-01	4.00532E-03	9.32148E-01	9.94577E-01	9.46140E-01	9.80585E-01
130.	1.01262E 00	4.04219E-03	9.81322E-01	1.04393E 00	9.95242E-01	1.03000E 00
135.	1.06559E 00	4.82627E-03	1.03229E 00	1.09888E 00	1.04483E 00	1.08634E 00
140.	1.12225E 00	6.43974E-03	1.08424E 00	1.16025E 00	1.09456E 00	1.14994E 00

Table F-74

ELECTRICAL RESISTIVITY OF WANL BERYLLIUM: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.577900E 00	1.575564E 00	2.335548E-03	0
8.775000D 01	1.616500E 00	1.619233E 00	-2.733231E-03	1
9.921999D 01	1.683200E 00	1.684998E 00	-1.797676E-03	2
1.231800D 02	1.886100E 00	1.881300E 00	4.799843E-03	3
1.359600D 02	2.016000E 00	2.018596E 00	-2.595901E-03	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 1.72043E-00

C_2 = -7.24401E-03

C_3 = 6.94105E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 4.792396E-03

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.58514E 00	3.64618E-03	1.55924E 00	1.61103E 00	1.56946E 00	1.60081E 00
85.	1.60618E 00	2.88781E-03	1.58212E 00	1.63024E 00	1.59376E 00	1.61860E 00
90.	1.63069E 00	2.87365E-03	1.60666E 00	1.65472E 00	1.61834E 00	1.64305E 00
95.	1.65868E 00	3.23417E-03	1.63382E 00	1.68354E 00	1.64477E 00	1.67259E 00
100.	1.69013E 00	3.60739E-03	1.66434E 00	1.71593E 00	1.67462E 00	1.70565E 00
105.	1.72506E 00	3.82727E-03	1.69869E 00	1.75143E 00	1.70860E 00	1.74152E 00
110.	1.76346E 00	3.84184E-03	1.73704E 00	1.78987E 00	1.74694E 00	1.77998E 00
115.	1.80532E 00	3.65888E-03	1.77940E 00	1.83125E 00	1.78959E 00	1.82106E 00
120.	1.85066E 00	3.35436E-03	1.82551E 00	1.87581E 00	1.83624E 00	1.86508E 00
125.	1.89947E 00	3.11860E-03	1.87488E 00	1.92405E 00	1.88606E 00	1.91288E 00
130.	1.95175E 00	3.29308E-03	1.92674E 00	1.97675E 00	1.93758E 00	1.96591E 00
135.	2.00749E 00	4.16013E-03	1.98021E 00	2.03478E 00	1.98961E 00	2.02538E 00
140.	2.06671E 00	5.69826E-03	2.03470E 00	2.09873E 00	2.04221E 00	2.09122E 00

Table F-75

ELECTRICAL RESISTIVITY OF WANL BERYLLIUM: POSTIRRADIATION-ANNEAL

Input Data		Calculated Data		Run No.
Temperature (^{o}K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	6.874000E-01	6.874510E-01	-5.102158E-05	0
8.800000D 01	7.258000E-01	7.228940E-01	2.905965E-03	1
9.839000D 01	7.677000E-01	7.728583E-01	-5.158305E-03	2
1.221700D 02	9.480000E-01	9.439362E-01	4.063785E-03	3
1.367400D 02	1.085999E 00	1.087760E 00	-1.760483E-03	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 9.04116E-01

C_2 = -8.20230E-03

C_3 = 6.98063E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.228236E-03

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (^{o}K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	6.94693E-01	3.97993E-03	6.66439E-01	7.22947E-01	6.77579E-01	7.11806E-01
85.	7.11271E-01	3.13691E-03	6.85054E-01	7.37489E-01	6.97783E-01	7.24760E-01
90.	7.31340E-01	3.08191E-03	7.05244E-01	7.57437E-01	7.18088E-01	7.44593E-01
95.	7.54900E-01	3.44801E-03	7.27970E-01	7.81830E-01	7.40073E-01	7.69726E-01
100.	7.81950E-01	3.84841E-03	7.54034E-01	8.09865E-01	7.65401E-01	7.98498E-01
105.	8.12489E-01	4.09929E-03	7.83922E-01	8.41057E-01	7.94862E-01	8.30116E-01
110.	8.46520E-01	4.13941E-03	8.17845E-01	8.75194E-01	8.28720E-01	8.64319E-01
115.	8.84040E-01	3.97611E-03	8.55796E-01	9.12284E-01	8.66943E-01	9.01138E-01
120.	9.25051E-01	3.68243E-03	8.97553E-01	9.52549E-01	9.09217E-01	9.40885E-01
125.	9.69553E-01	3.44257E-03	9.42635E-01	9.96470E-01	9.54750E-01	9.84356E-01
130.	1.01754E 00	3.58923E-03	9.90275E-01	1.04481E 00	1.00211E 00	1.03298E 00
135.	1.06903E 00	4.42676E-03	1.03957E 00	1.09848E 00	1.04999E 00	1.08806E 00
140.	1.12400E 00	5.97096E-03	1.08987E 00	1.15812E 00	1.09832E 00	1.14967E 00

Table F-76

ELECTRICAL RESISTIVITY OF WANL BERYLLIUM: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	6.774000E-01	6.901602E-01	-1.276022E-02	0
3.808999D 00	9.579999E-01	9.531934E-01	4.806519E-03	1
5.066999D 00	1.055200E 00	1.040065E 00	1.513481E-02	2
1.066000D 01	1.426999E 00	1.426294E 00	7.047653E-04	3
1.300000D 01	1.580000E 00	1.587884E 00	-7.884026E-03	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2\Phi$

$C_1 = 6.90160E-01$

$C_2 = 6.90557E-19$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.261801E-02$

d.f. = 3

$t_\alpha = 3.18$

$\alpha = 0.05$

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	6.90160E-01	9.61894E-03	6.39705E-01	7.40615E-01	6.59572E-01	7.20748E-01
1.000E 00	7.59216E-01	8.67794E-03	7.10517E-01	8.07915E-01	7.31620E-01	7.86812E-01
2.000E 00	8.28272E-01	7.80739E-03	7.81087E-01	8.75457E-01	8.03444E-01	8.53099E-01
3.000E 00	8.97327E-01	7.03350E-03	8.51389E-01	9.43265E-01	8.74961E-01	9.19694E-01
4.000E 00	9.66383E-01	6.39149E-03	9.21404E-01	1.01136E 00	9.46058E-01	9.86708E-01
5.000E 00	1.03544E 00	5.92438E-03	9.91111E-01	1.07977E 00	1.01660E 00	1.05428E 00
6.000E 00	1.10449E 00	5.67551E-03	1.06050E 00	1.14849E 00	1.08645E 00	1.12254E 00
7.000E 00	1.17355E 00	5.67370E-03	1.12955E 00	1.21754E 00	1.15551E 00	1.19159E 00
8.000E 00	1.24261E 00	5.91915E-03	1.19828E 00	1.28693E 00	1.22378E 00	1.26143E 00
9.000E 00	1.31166E 00	6.38341E-03	1.26669E 00	1.35663E 00	1.29136E 00	1.33196E 00
1.000E 01	1.38072E 00	7.02323E-03	1.33479E 00	1.42664E 00	1.35838E 00	1.40305E 00
1.100E 01	1.44977E 00	7.79549E-03	1.40261E 00	1.49694E 00	1.42498E 00	1.47456E 00
1.200E 01	1.51883E 00	8.66485E-03	1.47015E 00	1.56750E 00	1.49127E 00	1.54638E 00
1.300E 01	1.58788E 00	9.60499E-03	1.53746E 00	1.63831E 00	1.55734E 00	1.61843E 00

Table F-77

ELECTRICAL RESISTIVITY OF WANL BERYLLIUM:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (°K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.89864	0.87169	0.92558	0.88231	0.91496
85	0.90372	0.87868	0.92875	0.89079	0.91664
90	0.90856	0.88361	0.93352	0.89579	0.92134
100	0.91758	0.89083	0.94432	0.90158	0.93357
110	0.92568	0.89821	0.95315	0.90851	0.94285
120	0.93286	0.90659	0.95912	0.91768	0.94803
130	0.93913	0.91323	0.96502	0.92460	0.95365
135	0.94190	0.91399	0.96980	0.92403	0.95976
140	0.94446	0.91214	0.97677	0.92027	0.96864

Table F-78

ELECTRICAL RESISTIVITY OF TITANIUM: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.388000E 02	1.386418E 02	1.581421E-01	0
8.956000D 01	1.402000E 02	1.401418E 02	5.818176E-02	1
1.023600D 02	1.416000E 02	1.416995E 02	-9.953308E-02	2
1.268200D 02	1.445000E 02	1.446158E 02	-1.157837E-01	3
1.414000D 02	1.461000E 02	1.463163E 02	-2.163391E-01	4
1.907000D 02	1.519000E 02	1.518577E 02	4.232788E-02	5
2.126000D 02	1.544000E 02	1.542158E 02	1.841736E-01	6
2.342300D 02	1.566000E 02	1.564825E 02	1.175385E-01	7
2.857200D 02	1.615000E 02	1.616285E 02	-1.284637E-01	8

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.28635E 02

C_2 = 1.34424E-01

C_3 = -6.63180E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.655993E-01

d.f. = 6

t_α = 2.45

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.38964E C2	1.06732E-01	1.38482E 02	1.39447E 02	1.38703E 02	1.39226E 02
90.	1.40196E 02	8.85178E-02	1.39736E 02	1.40656E 02	1.39979E 02	1.40413E 02
100.	1.41414E 02	7.61470E-02	1.40967E 02	1.41860E 02	1.41227E 02	1.41600E 02
110.	1.42619E 02	6.99563E-02	1.42178E 02	1.43059E 02	1.42448E 02	1.42790E 02
120.	1.43811E 02	6.91580E-02	1.43371E 02	1.44250E 02	1.43641E 02	1.43980E 02
130.	1.44989E C2	7.19304E-02	1.44547E 02	1.45431E 02	1.44813E 02	1.45165E 02
140.	1.46154E 02	7.63136E-02	1.45708E 02	1.46601F 02	1.45967E 02	1.46341F 02
150.	1.47306E 02	8.08476E-02	1.46855E 02	1.47758E 02	1.47108E 02	1.47504F 02
160.	1.48445E C2	8.46404F-02	1.47989E 02	1.48900E 02	1.48237E 02	1.48652E 02
170.	1.49570E 02	8.72148E-02	1.49112E 02	1.50029E 02	1.49357E 02	1.49784E 02
180.	1.50682E 02	8.83811E-02	1.50222E 02	1.51142E 02	1.50466E 02	1.50899E 02
190.	1.51781E 02	8.81681E-02	1.51322E 02	1.52241E 02	1.51565E 02	1.51997E 02
200.	1.52867E 02	8.68149E-02	1.52409E 02	1.53325E 02	1.52654E 02	1.53080E 02
210.	1.53939E 02	8.48017E-02	1.53483E 02	1.54395E 02	1.53731E 02	1.54147E 02
220.	1.54998E 02	8.29221E-02	1.54545E 02	1.55452E 02	1.54795E 02	1.55201E 02
230.	1.56044E 02	8.23280E-02	1.55591E 02	1.56497E 02	1.55842E 02	1.56246E 02
240.	1.57077E 02	8.44434E-02	1.56621E 02	1.57532E 02	1.56870E 02	1.57283E 02
250.	1.58096E 02	9.06416E-02	1.57633E 02	1.58558E 02	1.57874E 02	1.58318E 02
260.	1.59102E 02	1.01804E-01	1.58626E 02	1.59578E 02	1.58852E 02	1.59351E 02
270.	1.60095E 02	1.18121E-01	1.59596E 02	1.60593E 02	1.59805E 02	1.60384E 02
280.	1.61074E 02	1.39307E-01	1.60544E 02	1.61604E 02	1.60733E 02	1.61415E 02
290.	1.62040E 02	1.64918E-01	1.61468E 02	1.62613E 02	1.61636E 02	1.62444E 02
300.	1.62993E 02	1.94550E-01	1.62367E 02	1.63619E 02	1.62517E 02	1.63470F 02

Table F-79

ELECTRICAL RESISTIVITY OF TITANIUM: POSTIRRADIAT

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	1.394000E 02	1.396672E 02	-2.671814E-01	0
1.411000D 02	1.465000E 02	1.466781E 02	-1.781158E-01	2
1.897500D 02	1.529000E 02	1.520326E 02	8.673706E-01	3
2.814199D 02	1.617000E 02	1.621220E 02	-4.219971E-01	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2 T$

$C_1 = +1.31148E\ 02$

$C_2 = +1.10062E\text{-}01$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 7.18862E\text{-}01$

d.f. = 2

$t_\alpha = 4.30$

$\alpha = 0.05$

Temperature (°K)	ρ (μohm-cm)	$s_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.39953E 02	5.72786E-01	1.36001E 02	1.43906E 02	1.37490E 02	1.42416E 02
90.	1.41054E 02	5.36069E-01	1.37198E 02	1.44910E 02	1.38749E 02	1.43359E 02
100.	1.42155E 02	5.01312E-01	1.38386E 02	1.45923E 02	1.39999E 02	1.44310E 02
110.	1.43255E 02	4.68951E-01	1.39564E 02	1.46946E 02	1.41239E 02	1.45272E 02
120.	1.44356E 02	4.39515E-01	1.40733E 02	1.47979E 02	1.42466E 02	1.46246E 02
130.	1.45456E 02	4.13629E-01	1.41890E 02	1.49023E 02	1.43678E 02	1.47235E 02
140.	1.46557E 02	3.91998E-01	1.43036E 02	1.50078E 02	1.44871E 02	1.48243E 02
150.	1.47658E 02	3.75357E-01	1.44171E 02	1.51145E 02	1.46044E 02	1.49272E 02
160.	1.48758E 02	3.64391E-01	1.45293E 02	1.52224E 02	1.47191E 02	1.50325E 02
170.	1.49859E 02	3.59619E-01	1.46403E 02	1.53315E 02	1.48313E 02	1.51405E 02
180.	1.50960E 02	3.61288E-01	1.47500E 02	1.54419E 02	1.49406E 02	1.52513E 02
190.	1.52060E 02	3.69309E-01	1.48585E 02	1.55535E 02	1.50472E 02	1.53648E 02
200.	1.53161E 02	3.83284E-01	1.49658E 02	1.56664E 02	1.51513E 02	1.54809E 02
210.	1.54261E 02	4.02594E-01	1.50719E 02	1.57804E 02	1.52530E 02	1.55993E 02
220.	1.55362E 02	4.26514E-01	1.51768E 02	1.58956E 02	1.53528E 02	1.57196E 02
230.	1.56463E 02	4.54317E-01	1.52806E 02	1.60119E 02	1.54509E 02	1.58416E 02
240.	1.57563E 02	4.85336E-01	1.53834E 02	1.61293E 02	1.55476E 02	1.59650E 02
250.	1.58664E 02	5.18995E-01	1.54851E 02	1.62476E 02	1.56432E 02	1.60896E 02
260.	1.59764E 02	5.54812E-01	1.55860E 02	1.63669E 02	1.57379E 02	1.62150E 02
270.	1.60865E 02	5.92398E-01	1.56860E 02	1.64871E 02	1.58318E 02	1.63412E 02
280.	1.61966E 02	6.31437E-01	1.57851E 02	1.66080E 02	1.59251E 02	1.64681E 02
290.	1.63066E 02	6.71675E-01	1.58836E 02	1.67297E 02	1.60178E 02	1.65955E 02
300.	1.64167E 02	7.12908E-01	1.59814E 02	1.68520E 02	1.61101E 02	1.67232E 02

Table F-80

ELECTRICAL RESISTIVITY OF TITANIUM: POSTIRRADIATION-ANNEAL

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
8.870000D 01	1.399000E 02	1.400636E 02	-1.636200E-01	1
1.039000D 02	1.423000E 02	1.420696E 02	2.303619E-01	2
1.369500D 02	1.462000E 02	1.462428E 02	-4.283142E-02	3
1.903000D 02	1.524000E 02	1.524345E 02	-3.450012E-02	4
2.829600D 02	1.616000E 02	1.615893E 02	1.069641E-02	5

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 1.27268E 02

C_2 = 1.54737E-01

C_3 = -1.18196E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.036875E-01

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.38891E 02	1.95182E-01	1.37678E 02	1.40104E 02	1.38052E 02	1.39730E 02
90.	1.40237E 02	1.56583E-01	1.39133E 02	1.41342E 02	1.39564E 02	1.40911E 02
100.	1.41560E 02	1.28235E-01	1.40525E 02	1.42595E 02	1.41009E 02	1.42112E 02
110.	1.42859E 02	1.12280E-01	1.41859E 02	1.43859E 02	1.42376E 02	1.43342E 02
120.	1.44135E 02	1.08983E-01	1.43141E 02	1.45128E 02	1.43666E 02	1.44603E 02
130.	1.45387E 02	1.15174E-01	1.44381E 02	1.46393E 02	1.44891E 02	1.45882E 02
140.	1.46615E 02	1.26164E-01	1.45585E 02	1.47645E 02	1.46072E 02	1.47157E 02
150.	1.47820E 02	1.38279E-01	1.46761E 02	1.48878E 02	1.47225E 02	1.48414E 02
160.	1.49001E 02	1.49330E-01	1.47914E 02	1.50087E 02	1.48358E 02	1.49643E 02
170.	1.50158E 02	1.58161E-01	1.49049E 02	1.51267E 02	1.49478E 02	1.50838E 02
180.	1.51292E 02	1.64222E-01	1.50166E 02	1.52417E 02	1.50585E 02	1.51998E 02
190.	1.52402E 02	1.67333E-01	1.51268E 02	1.53535E 02	1.51682E 02	1.53121E 02
200.	1.53488E 02	1.67588E-01	1.52354E 02	1.54622E 02	1.52767E 02	1.54209E 02
210.	1.54551E 02	1.65348E-01	1.53423E 02	1.55679E 02	1.53840E 02	1.55262E 02
220.	1.55590E 02	1.61304E-01	1.54473E 02	1.56707E 02	1.54896E 02	1.56283E 02
230.	1.56605E 02	1.56564E-01	1.55501E 02	1.57710E 02	1.55932E 02	1.57279E 02
240.	1.57597E 02	1.52815E-01	1.56502E 02	1.58692E 02	1.56940E 02	1.58254E 02
250.	1.58565E 02	1.52334E-01	1.57472E 02	1.59659E 02	1.57910E 02	1.59220E 02
260.	1.59510E 02	1.57736E-01	1.58402E 02	1.60618E 02	1.58832E 02	1.60188E 02
270.	1.60431E 02	1.71234E-01	1.59287E 02	1.61575E 02	1.59695E 02	1.61167E 02
280.	1.61328E 02	1.93935E-01	1.60119E 02	1.62538E 02	1.60494E 02	1.62162E 02
290.	1.62202E 02	2.25767E-01	1.60894E 02	1.63509E 02	1.61231E 02	1.63173E 02
300.	1.63052E 02	2.66012E-01	1.61611E 02	1.64493E 02	1.61908E 02	1.64196E 02

Table F-81

ELECTRICAL RESISTIVITY OF TITANIUM: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	1.386000E 02	1.385847E 02	1.524353E-02	0
1.462999D 00	1.389000E 02	1.388043E 02	9.565735E-02	1
1.945999D 00	1.388000E 02	1.388768E 02	-7.684326E-02	2
4.094999D 00	1.390000E 02	1.391994E 02	-1.993866E-01	3
4.995999D 00	1.395000E 02	1.393346E 02	1.653748E-01	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

C_1 = 1.38585E 02

C_2 = 1.50097E-18

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.657220E-01

d.f. = 3

t_α = 3.18

α = 0.05

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	1.38585E 02	1.26313E-01	1.37922E 02	1.39247E 02	1.38183E 02	1.38986E 02
1.000E 00	1.38735E 02	9.62247E-02	1.38125E 02	1.39344E 02	1.38429E 02	1.39041E 02
2.000E 00	1.38885E 02	7.68846E-02	1.38304E 02	1.39466E 02	1.38640E 02	1.39129E 02
3.000E 00	1.39035E 02	7.68846E-02	1.38454E 02	1.39616E 02	1.38791E 02	1.39280E 02
4.000E 00	1.39185E 02	9.62247E-02	1.38576E 02	1.39795E 02	1.38879E 02	1.39491E 02
5.000E 00	1.39335E 02	1.26314E-01	1.38673E 02	1.39998E 02	1.38934E 02	1.39737E 02

Table F-82

ELECTRICAL RESISTIVITY OF TITANIUM:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^oK)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.6220	-0.6526	1.8966	-0.1759	1.4199
100	0.6620	-0.4949	1.8189	0.0699	1.2540
120	0.6890	-0.4409	1.8189	0.1517	1.2262
140	0.7110	-0.4381	1.8601	0.1344	1.2875
160	0.7210	-0.4561	1.8981	0.0903	1.3516
180	0.7220	-0.4705	1.9145	0.0632	1.3807
200	0.7120	-0.4769	1.9009	0.0597	1.3642
220	0.6930	-0.4809	1.8669	0.0684	1.3175
240	0.6630	-0.5067	1.8327	0.0463	1.2796
260	0.6230	-0.5896	1.8356	0.0715	1.3175
280	0.5740	-0.7695	1.9175	0.3299	1.4779
300	0.5140	-1.0758	2.1038	-0.7267	1.7547

Table F-83

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.7399990 01	2.340500E 03	2.338169E 03	2.330811E 00	0
8.9849990 01	2.275300E 03	2.275972E 03	-6.721191E-01	1
1.2385000 02	2.115300E 03	2.118196E 03	-2.896240E 00	2
2.0490000 02	1.813200E 03	1.813417E 03	-2.165527E-01	3
2.1980000 02	1.768000E 03	1.768323E 03	-3.227539E-01	4
2.5985990 02	1.669000E 03	1.663926E 03	5.073975E 00	5
2.7318990 02	1.635100E 03	1.634632E 03	4.682617E-01	6
2.9022000 02	1.597400E 03	1.601162E 03	-3.761719E 00	7

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 2.77804E 03

C_2 = -6.27515E-00

C_3 = 7.64946E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 3.302686E-00

d.f. = 5

t_α = 2.57

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.32498E 03	2.32601E 00	2.31460E 03	2.33537E 03	2.31901E 03	2.33096E 03
90.	2.27524E 03	1.99352E 00	2.26532E 03	2.28515E 03	2.27011E 03	2.28036E 03
100.	2.22702E 03	1.79702E 00	2.21736E 03	2.23668E 03	2.22240E 03	2.23164E 03
110.	2.18033E 03	1.73081E 00	2.17075E 03	2.18991E 03	2.17588E 03	2.18478E 03
120.	2.13517E 03	1.76471E 00	2.12555E 03	2.14480E 03	2.13064E 03	2.13971E 03
130.	2.09155E 03	1.85646E 00	2.08181E 03	2.10128E 03	2.08677E 03	2.09632E 03
140.	2.04945E 03	1.96852E 00	2.03957E 03	2.05933E 03	2.04439E 03	2.05451E 03
150.	2.00888E 03	2.07454E 00	1.99886E 03	2.01890E 03	2.00355E 03	2.01421E 03
160.	1.96984E 03	2.15795E 00	1.95970E 03	1.97998E 03	1.96430E 03	1.97539E 03
170.	1.93233E 03	2.20897E 00	1.92212E 03	1.94255E 03	1.92666E 03	1.93801E 03
180.	1.89636E 03	2.22225E 00	1.88612E 03	1.90659E 03	1.89064E 03	1.90207E 03
190.	1.86191E 03	2.19556E 00	1.85171E 03	1.87210E 03	1.85626E 03	1.86755E 03
200.	1.82899E 03	2.12931E 00	1.81889E 03	1.83909E 03	1.82352E 03	1.83446E 03
210.	1.79760E 03	2.02678E 00	1.78764E 03	1.80756E 03	1.79239E 03	1.80281E 03
220.	1.76774E 03	1.89526E 00	1.75795E 03	1.77753E 03	1.76287E 03	1.77261E 03
230.	1.73941E 03	1.74855E 00	1.72981E 03	1.74902E 03	1.73492E 03	1.74391E 03
240.	1.71261E 03	1.61114E 00	1.70317E 03	1.72206E 03	1.70847E 03	1.71675E 03
250.	1.68734E 03	1.52314E 00	1.67800E 03	1.69669E 03	1.68343E 03	1.69126E 03
260.	1.66360E 03	1.53729E 00	1.65424E 03	1.67297E 03	1.65965E 03	1.66755E 03
270.	1.64140E 03	1.69714E 00	1.63185E 03	1.65094E 03	1.63703E 03	1.64576E 03
280.	1.62072E 03	2.01162E 00	1.61078E 03	1.63065E 03	1.61555E 03	1.62589E 03
290.	1.60157E 03	2.46136E 00	1.59098E 03	1.61215E 03	1.59524E 03	1.60789E 03

Table F-85

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION-ANNEAL

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	3.197000E 03	3.201891E 03	-4.890625E 00	0
8.979999D 01	3.177000E 03	3.172219E 03	4.780518E 00	1
1.244000D 02	3.091600E 03	3.089900E 03	1.699707E 00	2
2.012000D 02	2.908500E 03	2.909668E 03	-1.168457E 00	3
2.142000D 02	2.878100E 03	2.879500E 03	-1.399902E 00	4
2.784600D 02	2.732800E 03	2.731819E 03	9.804688E-01	5

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 3.38912E 03

C_2 = -2.44147E-00

C_3 = 2.90866E-04

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 4.240552E-00

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	3.19566E 03	3.01490E 00	3.17912E 03	3.21221E 03	3.18607E 03	3.20525E 03
90.	3.17174E 03	2.56389E 00	3.15598E 03	3.18750E 03	3.16359E 03	3.17989E 03
100.	3.14788E 03	2.31253E 00	3.13252E 03	3.16324E 03	3.14053E 03	3.15523E 03
110.	3.12408E 03	2.24777E 00	3.10881E 03	3.13934E 03	3.11693E 03	3.13122E 03
120.	3.10033E 03	2.31814E 00	3.08496E 03	3.11570E 03	3.09296E 03	3.10770E 03
130.	3.07664E 03	2.45853E 00	3.06105E 03	3.09223E 03	3.06882E 03	3.08446E 03
140.	3.05301E 03	2.61596E 00	3.03717E 03	3.06886E 03	3.04469E 03	3.06133E 03
150.	3.02944E 03	2.75607E 00	3.01336E 03	3.04552E 03	3.02068E 03	3.03821E 03
160.	3.00593E 03	2.85896E 00	2.98967E 03	3.02219E 03	2.99684E 03	3.01502E 03
170.	2.98247E 03	2.91458E 00	2.96611E 03	2.99884E 03	2.97321E 03	2.99174E 03
180.	2.95908E 03	2.91944E 00	2.94271E 03	2.97545E 03	2.94979E 03	2.96836E 03
190.	2.93574E 03	2.87575E 00	2.91945E 03	2.95203E 03	2.92659E 03	2.94488E 03
200.	2.91246E 03	2.79135E 00	2.89631E 03	2.92860E 03	2.90358E 03	2.92133E 03
210.	2.88924E 03	2.68175E 00	2.87328E 03	2.90519E 03	2.88071E 03	2.89776E 03
220.	2.86607E 03	2.57293E 00	2.85030E 03	2.88184E 03	2.85789E 03	2.87425E 03
230.	2.84297E 03	2.50441E 00	2.82731E 03	2.85863E 03	2.83500E 03	2.85093E 03
240.	2.81992E 03	2.52800E 00	2.80422E 03	2.83562E 03	2.91188E 03	2.82796E 03
250.	2.79693E 03	2.69518E 00	2.78095E 03	2.81291E 03	2.78836E 03	2.80550E 03
260.	2.77400E 03	3.03766E 00	2.75741E 03	2.79059E 03	2.76434E 03	2.78366E 03
270.	2.75112E 03	3.55837E 00	2.73352E 03	2.76873E 03	2.73981E 03	2.76244E 03
280.	2.72831E 03	4.24205E 00	2.70924E 03	2.74738E 03	2.71482E 03	2.74180E 03
290.	2.70555E 03	5.06962E 00	2.68453E 03	2.72657E 03	2.68943E 03	2.72167E 03

Table F-84

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	3.526800E 03	3.531958E 03	-5.157959E 00	0
9.214000D 01	3.512900E 03	3.509524E 03	3.375732E 00	1
1.230300D 02	3.451500E 03	3.447113E 03	4.386963E 00	2
1.934000D 02	3.228700F 03	3.227094E 03	1.606445E 00	3
2.111000D 02	3.148900E 03	3.154723E 03	-5.823486E 00	4
2.894800D 02	2.753600E 03	2.751984E 03	1.615479E 00	5

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 3.57185E 03

C_2 = 3.30119E-01

C_3 = -1.09242E-02

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.667125E-00

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	3.52835E 03	4.06276E 00	3.50617E 03	3.55052E 03	3.51543E 03	3.54126E 03
90.	3.51308E 03	3.45676E 00	3.49197E 03	3.53419E 03	3.50208E 03	3.52407E 03
100.	3.49562E 03	3.07233E 00	3.47512E 03	3.51612E 03	3.48585E 03	3.50539E 03
110.	3.47598E 03	2.90866E 00	3.45572E 03	3.49624E 03	3.46673E 03	3.48523E 03
120.	3.45416E 03	2.92536E 00	3.43388E 03	3.47444E 03	3.44485E 03	3.46346E 03
130.	3.43015E 03	3.05585E 00	3.40967E 03	3.45062E 03	3.42043E 03	3.43987E 03
140.	3.40395E 03	3.23574E 00	3.38320E 03	3.42471E 03	3.39366E 03	3.41424E 03
150.	3.37558E 03	3.41793E 00	3.35453E 03	3.39662E 03	3.36471E 03	3.38644E 03
160.	3.34501E 03	3.57295E 00	3.32371E 03	3.36632E 03	3.33365E 03	3.35637E 03
170.	3.31226E 03	3.68424E 00	3.29077E 03	3.33376E 03	3.30055E 03	3.32398E 03
180.	3.27733E 03	3.74402E 00	3.25573E 03	3.29893E 03	3.26542E 03	3.28924E 03
190.	3.24021E 03	3.75147E 00	3.21860E 03	3.26182E 03	3.22828E 03	3.25214E 03
200.	3.20091E 03	3.71182E 00	3.17937E 03	3.22245E 03	3.18910E 03	3.21271E 03
210.	3.15942E 03	3.63686E 00	3.13801E 03	3.18083E 03	3.14786E 03	3.17099E 03
220.	3.11575E 03	3.54689F 00	3.09449E 03	3.13701E 03	3.10447E 03	3.12703E 03
230.	3.06989E 03	3.47255E 00	3.04875E 03	3.09103E 03	3.05885E 03	3.08093E 03
240.	3.02185E 03	3.45576E 00	3.00074E 03	3.04296E 03	3.01086E 03	3.03284E 03
250.	2.97162E 03	3.54616E 00	2.95036E 03	2.99288E 03	2.96034E 03	2.98290F 03
260.	2.91921E 03	3.78963E 00	2.89753E 03	2.94089E 03	2.90716E 03	2.93126E 03
270.	2.86461E 03	4.21489E 00	2.84215E 03	2.88707E 03	2.85121E 03	2.87802F 03
280.	2.80783E 03	4.82861E 00	2.78415E 03	2.83151E 03	2.79248E 03	2.82319E 03
290.	2.74886F 03	5.62131E 00	2.72348E 03	2.77425E 03	2.73099E 03	2.76674E 03

Table F-86

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	2.327600E 03	2.375937E 03	-4.833740E 01	0
3.221999D 00	3.319700E 03	3.207259E 03	1.124414E 02	1
4.2870000 00	3.378800E 03	3.387472E 03	-8.671875E 00	2
9.0200000 00	3.476400E 03	3.619928E 03	-1.435281E 02	3
1.1005000 01	3.529300E 03	3.441195E 03	8.810474E 01	4

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi + C_3\phi^2$

$C_1 = 2.37594E\ 03$

$C_2 = 3.24754E-15$

$C_3 = -2.07139E-33$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.473389E\ 02$

d.f. = 2

$t_\alpha = 4.30$

$\alpha = 0.05$

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	2.37594E 03	1.43276E 02	1.49222E 03	3.25966E 03	1.75985E 03	2.99203E 03
1.000E 00	2.67998E 03	1.04635E 02	1.90291E 03	3.45704E 03	2.23005E 03	3.12991E 03
2.000E 00	2.94259E 03	8.86474E 01	2.20320E 03	3.68198E 03	2.56141E 03	3.32377E 03
3.000E 00	3.16378E 03	9.10965E 01	2.41890E 03	3.90865E 03	2.77206E 03	3.55549E 03
4.000E 00	3.34353E 03	1.00084E 02	2.57763E 03	4.10943E 03	2.91317E 03	3.77389E 03
5.000E 00	3.48186E 03	1.07084E 02	2.69865E 03	4.26507E 03	3.02140E 03	3.94232E 03
6.000E 00	3.57876E 03	1.08674E 02	2.79151E 03	4.36601E 03	3.11146E 03	4.04606E 03
7.000E 00	3.63423E 03	1.04466E 02	2.85759E 03	4.41088E 03	3.18503E 03	4.08344E 03
8.000E 00	3.64828E 03	9.66947E 01	2.89047E 03	4.40609E 03	3.23249E 03	4.06407E 03
9.000E 00	3.62090E 03	9.16552E 01	2.87476E 03	4.36704E 03	3.22678E 03	4.01502E 03
1.000E 01	3.55209E 03	1.00261E 02	2.78576E 03	4.31842F 03	3.12097E 03	3.98321E 03
1.100E 01	3.44185E 03	1.30378E 02	2.59586E 03	4.28784E 03	2.88123E 03	4.00248E 03

Table F-87

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (°K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	1203.3	1185.9	1220.7	1193.3	1213.4
100	1268.6	1252.4	1284.7	1260.9	1276.2
120	1318.9	1302.9	1334.9	1311.5	1326.4
140	1354.5	1338.1	1370.8	1346.2	1362.7
160	1375.1	1358.3	1392.0	1366.0	1384.2
180	1380.9	1363.9	1397.9	1371.5	1390.4
200	1371.9	1355.0	1388.8	1362.7	1381.1
220	1348.0	1331.4	1364.5	1339.5	1356.5
240	1309.2	1293.0	1325.4	1301.4	1317.0
260	1255.6	1239.2	1271.9	1247.4	1263.7
280	1187.1	1169.4	1204.7	1176.6	1197.5

Table F-88

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P4 WITH LN_2 BATH

Input Data: Temperature (^oK)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	3.194200E 03	3.197891E 03	-3.691406E 00	0
8.985999D 01	3.167700E 03	3.165743E 03	1.957275E 00	1
1.255000D 02	3.078700E 03	3.074326E 03	4.373779E 00	2
1.774000D 02	2.941000E 03	2.942631E 03	-1.631104E 00	3
2.171100D 02	2.841300E 03	2.843012E 03	-1.712158E 00	4
2.339000D 02	2.801100E 03	2.801189E 03	-8.959961E-02	5
3.058799D 02	2.624700E 03	2.623904E 03	7.956543E-01	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2 +$

C_1 = 3.39978E 03

C_2 = -2.63273E-00

C_3 = 3.14469E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 3.271864E-00

d.f. = 4

t_α = 2.78

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	3.19117E 03	2.29171E 00	3.18007E 03	3.20228E 03	3.18480E 03	3.19755E 03
90.	3.16538E 03	1.97497E 00	3.15476E 03	3.17601E 03	3.15989E 03	3.17087E 03
100.	3.13965E 03	1.75159E 00	3.12934E 03	3.14997E 03	3.13478E 03	3.14452E 03
110.	3.11399E 03	1.62330E 00	3.10383E 03	3.12414E 03	3.10947E 03	3.11850E 03
120.	3.08838E 03	1.57965E 00	3.07828E 03	3.09848E 03	3.08399E 03	3.09277E 03
130.	3.06284E 03	1.59866E 00	3.05272E 03	3.07296E 03	3.05840E 03	3.06728E 03
140.	3.03736E 03	1.65425E 00	3.02717E 03	3.04755E 03	3.03276E 03	3.04196E 03
150.	3.01195E 03	1.72377E 00	3.00167E 03	3.02223E 03	3.00715E 03	3.01674E 03
160.	2.98659E 03	1.79080E 00	2.97623E 03	2.99696E 03	2.98162E 03	2.99157E 03
170.	2.96131E 03	1.84480E 00	2.95086E 03	2.97175E 03	2.95618E 03	2.96643E 03
180.	2.93608E 03	1.87986E 00	2.92559E 03	2.94657E 03	2.93085E 03	2.94130E 03
190.	2.91091E 03	1.89346E 00	2.90041E 03	2.92142E 03	2.90565E 03	2.91618E 03
200.	2.88581E 03	1.88604E 00	2.87531E 03	2.89631E 03	2.88057E 03	2.89106E 03
210.	2.86078E 03	1.86088E 00	2.85031E 03	2.87124E 03	2.85560E 03	2.86595E 03
220.	2.83580E 03	1.82447E 00	2.82539E 03	2.84622E 03	2.83073E 03	2.84087E 03
230.	2.81089E 03	1.78724E 00	2.80052E 03	2.82125E 03	2.80592E 03	2.81586E 03
240.	2.78604E 03	1.76430E 00	2.77571E 03	2.79637E 03	2.78113E 03	2.79094E 03
250.	2.76125E 03	1.77486E 00	2.75091E 03	2.77160E 03	2.75632E 03	2.76619E 03
260.	2.73653E 03	1.84008E 00	2.72609E 03	2.74697E 03	2.73141E 03	2.74164E 03
270.	2.71187E 03	1.97809E 00	2.70124E 03	2.72250E 03	2.70637E 03	2.71737E 03
280.	2.68727E 03	2.19929E 00	2.67631E 03	2.69823E 03	2.68116E 03	2.69339E 03
290.	2.66274E 03	2.50547E 00	2.65128E 03	2.67419E 03	2.65577E 03	2.66970E 03
300.	2.63826E 03	2.89254E 00	2.62612E 03	2.65041E 03	2.63022E 03	2.64631E 03
310.	2.61386E 03	3.35425E 00	2.60083E 03	2.62688E 03	2.60453E 03	2.62318E 03

Table F-89

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P5 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	3.194800E 03	3.193742E 03	1.057861E 00	0
8.985999D 01	3.161500E 03	3.160919E 03	5.805664E-01	1
1.255000D 02	3.066500E 03	3.068439E 03	-1.939209E 00	2
1.774400D 02	2.934600E 03	2.937388E 03	-2.788330E 00	3
2.171100D 02	2.841800E 03	2.840272E 03	1.527588E 00	4
2.339000D 02	2.802800E 03	2.799945E 03	2.854980E 00	5
3.058799D 02	2.631000E 03	2.632291E 03	-1.291260E 00	6

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 3.40333E 03

C_2 = -2.77120E-00

C_3 = 8.18904E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.507151E-00

d.f. = 4

t_α = 2.78

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	3.18687E 03	1.75608E 00	3.17836E 03	3.19538E 03	3.18199E 03	3.19175E 03
90.	3.16055E 03	1.51339E 00	3.15241E 03	3.16869E 03	3.15634E 03	3.16476E 03
100.	3.13440E 03	1.34224E 00	3.12649E 03	3.14230E 03	3.13066E 03	3.13813E 03
110.	3.10840E 03	1.24394E 00	3.10062E 03	3.11618E 03	3.10495E 03	3.11186E 03
120.	3.08258E 03	1.21050E 00	3.07484E 03	3.09031E 03	3.07921E 03	3.08594E 03
130.	3.05691E 03	1.22505E 00	3.04915E 03	3.06467E 03	3.05350E 03	3.06032E 03
140.	3.03141E 03	1.26764E 00	3.02360E 03	3.03922E 03	3.02789E 03	3.03493E 03
150.	3.00607E 03	1.32089E 00	2.99819E 03	3.01395E 03	3.00240E 03	3.00974E 03
160.	2.98090E 03	1.37224E 00	2.97295E 03	2.98884E 03	2.97708E 03	2.98471E 03
170.	2.95589E 03	1.41360E 00	2.94789E 03	2.96389E 03	2.95196E 03	2.95982E 03
180.	2.93104E 03	1.44046E 00	2.92301E 03	2.93908E 03	2.92704E 03	2.93505E 03
190.	2.90636E 03	1.45086E 00	2.89831E 03	2.91441E 03	2.90233E 03	2.91039E 03
200.	2.88184E 03	1.44516E 00	2.87380E 03	2.88989E 03	2.87783E 03	2.88586E 03
210.	2.85749E 03	1.42589E 00	2.84947E 03	2.86551E 03	2.85352E 03	2.86145E 03
220.	2.83330E 03	1.39796E 00	2.82532E 03	2.84128E 03	2.82941E 03	2.83718E 03
230.	2.80927E 03	1.36948E 00	2.80133E 03	2.81721E 03	2.80546E 03	2.81308E 03
240.	2.78541E 03	1.35187E 00	2.77749E 03	2.79333E 03	2.78165E 03	2.78917E 03
250.	2.76171E 03	1.35996E 00	2.75378E 03	2.76964E 03	2.75793E 03	2.76549E 03
260.	2.73817E 03	1.40995E 00	2.73018E 03	2.74617E 03	2.73425E 03	2.74209E 03
270.	2.71480E 03	1.51571E 00	2.70666E 03	2.72295E 03	2.71059E 03	2.71901E 03
280.	2.69159E 03	1.68523E 00	2.68319E 03	2.69999E 03	2.68691E 03	2.69628E 03
290.	2.66855E 03	1.91986E 00	2.65977E 03	2.67733E 03	2.66321E 03	2.67389E 03
300.	2.64567E 03	2.21649E 00	2.63637E 03	2.65497E 03	2.63951E 03	2.65183E 03

Table F-90

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P6 WITH LN_2 BATH

Input Data: Temperature (^oK)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.7399990 01	3.204400E 03	3.192310E 03	1.209033E 01	0
8.9689990 01	3.133000E 03	3.147556E 03	-1.455640E 01	1
1.2468000 02	3.026100E 03	3.026910E 03	-8.100586E-01	2
1.7666000 02	2.871100E 03	2.866175E 03	4.925049E 00	3
2.1774000 02	2.755400E 03	2.754784E 03	6.154785E-01	4
2.3560000 02	2.708400E 03	2.710662E 03	-2.262207E 00	5

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 3.50256E 03

C_2 = -4.32498E-00

C_3 = 4.09085E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.137941E 01

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	3.18274E 03	8.41236E 00	3.13774E 03	3.22774E 03	3.15599E 03	3.20949E 03
90.	3.14644E 03	6.85719E 00	3.10420E 03	3.18869E 03	3.12464E 03	3.16825E 03
100.	3.11097E 03	6.30546E 00	3.06960E 03	3.15234E 03	3.09092E 03	3.13102E 03
110.	3.07631E 03	6.55849E 00	3.03454E 03	3.11807E 03	3.05545E 03	3.09716E 03
120.	3.04247E 03	7.19729E 00	2.99965E 03	3.08528E 03	3.01958E 03	3.06535E 03
130.	3.00944E 03	7.88124E 00	2.96543E 03	3.05346E 03	2.98438E 03	3.03451E 03
140.	2.97724E 03	8.42190E 00	2.93222E 03	3.02226E 03	2.95046E 03	3.00402E 03
150.	2.94585E 03	8.72933E 00	2.90025E 03	2.99146E 03	2.91809E 03	2.97361E 03
160.	2.91528E 03	8.76740E 00	2.86960E 03	2.96097E 03	2.88740E 03	2.94316E 03
170.	2.88553E 03	8.53490E 00	2.84030E 03	2.93077E 03	2.85839E 03	2.91268E 03
180.	2.85660E 03	8.06423E 00	2.81225E 03	2.90095E 03	2.83096E 03	2.88225E 03
190.	2.82849E 03	7.43677E 00	2.78526E 03	2.87172E 03	2.80484E 03	2.85214E 03
200.	2.80119E 03	6.82099E 00	2.75900E 03	2.84338E 03	2.77950E 03	2.82288E 03
210.	2.77472E 03	6.52178E 00	2.73301E 03	2.81642E 03	2.75398E 03	2.79546E 03
220.	2.74906E 03	6.93878E 00	2.70667E 03	2.79144E 03	2.72699E 03	2.77112E 03
230.	2.72422E 03	8.31677E 00	2.67940E 03	2.76904E 03	2.69777E 03	2.75066E 03
240.	2.70019E 03	1.06009E 01	2.65074E 03	2.74965E 03	2.66648E 03	2.73390E 03

Table F-91

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P7 WITH LN_2 BATH

Input Data: Temperature (^oK)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
8.900999D 01	3.112400E 03	3.113576E 03	-1.176270E 00	1
1.214400D 02	2.998900E 03	2.997422E 03	1.478271E 00	2
1.700400D 02	2.833800E 03	2.832708E 03	1.091309E 00	3
2.083700D 02	2.711200E 03	2.710719E 03	4.809570E-01	4
2.236400D 02	2.660900E 03	2.664065E 03	-3.165527E 00	5
2.688599D 02	2.533700E 03	2.532407E 03	1.292969E 00	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 3.45807E 03

C_2 = -4.08175E-00

C_3 = 2.37611E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.358212E-00

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	3.14673E 03	2.49126E 00	3.13583E 03	3.15764E 03	3.13881E 03	3.15466E 03
90.	3.10996E 03	2.05054E 00	3.10002E 03	3.11989E 03	3.10344E 03	3.11648E 03
100.	3.07365E 03	1.71032E 00	3.06439E 03	3.08292E 03	3.06821E 03	3.07909E 03
110.	3.03783E 03	1.48078E 00	3.02897E 03	3.04668E 03	3.03312E 03	3.04253E 03
120.	3.00247E 03	1.36143E 00	2.99381E 03	3.01113E 03	2.99814E 03	3.00680E 03
130.	2.96760E 03	1.33244E 00	2.95898E 03	2.97621E 03	2.96336E 03	2.97183E 03
140.	2.93319E 03	1.35928E 00	2.92454E 03	2.94185E 03	2.92887E 03	2.93752E 03
150.	2.89927E 03	1.40745E 00	2.89053E 03	2.90800E 03	2.89479E 03	2.90374E 03
160.	2.86582E 03	1.45168E 00	2.85701E 03	2.87462E 03	2.86120E 03	2.87043E 03
170.	2.83284E 03	1.47674E 00	2.82399E 03	2.84169E 03	2.82814E 03	2.83754E 03
180.	2.80034E 03	1.47515E 00	2.79149E 03	2.80918E 03	2.79565E 03	2.80503E 03
190.	2.76831E 03	1.44567E 00	2.75952E 03	2.77711E 03	2.76372E 03	2.77291E 03
200.	2.73676E 03	1.39295E 00	2.72805E 03	2.74547E 03	2.73233E 03	2.74119E 03
210.	2.70569E 03	1.32921E 00	2.69708E 03	2.71429E 03	2.70146E 03	2.70991E 03
220.	2.67509E 03	1.27689E 00	2.66656E 03	2.68361E 03	2.67103E 03	2.67915E 03
230.	2.64496E 03	1.27024E 00	2.63644E 03	2.65348E 03	2.64092E 03	2.64900E 03
240.	2.61531E 03	1.34905E 00	2.60667E 03	2.62395E 03	2.61102E 03	2.61960E 03
250.	2.58614E 03	1.54120E 00	2.57718E 03	2.59510E 03	2.58124E 03	2.59104E 03
260.	2.55744E 03	1.85103E 00	2.54790E 03	2.56697E 03	2.55155E 03	2.56332E 03
270.	2.52921E 03	2.26742E 00	2.51881E 03	2.53962E 03	2.52200E 03	2.53642E 03

Table F-92

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P8 WITH ICE-WATER BATH

Input Data: Temperature (^{o}K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
2.731499D 02	2.518900E 03	2.522401E 03	-3.501221E 00	0
2.762500D 02	2.517600E 03	2.514458E 03	3.142334E 00	1
2.849900D 02	2.493100E 03	2.492154E 03	9.460449E-01	2
3.088098D 02	2.431700E 03	2.432061E 03	-3.610840E-01	3
3.507998D 02	2.327900E 03	2.328595E 03	-6.955566E-01	4
3.708799D 02	2.280700E 03	2.280230E 03	4.699707E-01	5

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 3.28972E 03

C_2 = -3.05306E-00

C_3 = 8.92957E-04

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.820332E-00

d.f. = 3

t_α = 3.18

α = 0.05

Temperature (^{o}K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
270.	2.53049E 03	2.25381E 00	2.51901E 03	2.54197E 03	2.52332E 03	2.53766E 03
280.	2.50487E 03	1.50244E 00	2.49471E 03	2.51503E 03	2.50009E 03	2.50965E 03
290.	2.47943E 03	1.53710E 00	2.46922E 03	2.48965E 03	2.47454E 03	2.48432E 03
300.	2.45417E 03	1.92856E 00	2.44330E 03	2.46503E 03	2.44804E 03	2.46030E 03
310.	2.42908E 03	2.26526E 00	2.41758E 03	2.44059E 03	2.42188E 03	2.43629E 03
320.	2.40418E 03	2.41951E 00	2.39236E 03	2.41600E 03	2.39649E 03	2.41187E 03
330.	2.37945E 03	2.37191E 00	2.36774E 03	2.39117E 03	2.37191E 03	2.38700E 03
340.	2.35491E 03	2.15563E 00	2.34362E 03	2.36619E 03	2.34805E 03	2.36176E 03
350.	2.33054E 03	1.89135E 00	2.31974E 03	2.34134E 03	2.32452E 03	2.33655E 03
360.	2.30635E 03	1.88538E 00	2.29556E 03	2.31713E 03	2.30035E 03	2.31234E 03
370.	2.28233E 03	2.49457E 00	2.27036E 03	2.29431E 03	2.27440E 03	2.29027E 03

Table F-93

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P9 WITH ICE-WATER BATH

Input Data: Temperature (^{o}K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
2.731499D 02	2.364500E 03	2.363942E 03	5.581055E-01	0
3.055498D 02	2.280700E 03	2.281719E 03	-1.019043E 00	1
3.447500D 02	2.182700E 03	2.182239E 03	4.614258E-01	2

Least Squares Fit Coefficients

$\rho = C_1 + C_2 T$

$C_1 = 3.05713E\ 03$

$C_2 = -2.53775E-00$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.250136E-00$

d.f. = 1

$t_\alpha = 12.71$

$\alpha = 0.05$

Temperature (^{o}K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
270.	2.37194E 03	1.17909E 00	2.35009E 03	2.39378E 03	2.35695E 03	2.38692E 03
280.	2.34656E 03	9.95637E-01	2.32625E 03	2.36687E 03	2.33390E 03	2.35921E 03
290.	2.32118E 03	8.44926E-01	2.30200E 03	2.34036E 03	2.31044E 03	2.33192E 03
300.	2.29580E 03	7.47049E-01	2.27729E 03	2.31431E 03	2.28631E 03	2.30530E 03
310.	2.27043E 03	7.23768E-01	2.25207E 03	2.28879E 03	2.26123E 03	2.27962E 03
320.	2.24505E 03	7.81775E-01	2.22631E 03	2.26379E 03	2.23511E 03	2.25498E 03
330.	2.21967E 03	9.05582E-01	2.20005E 03	2.23929E 03	2.20816E 03	2.23118E 03
340.	2.19429E 03	1.07264E 00	2.17336E 03	2.21523E 03	2.18066E 03	2.20793E 03
350.	2.16892E 03	1.26594E 00	2.14630E 03	2.19153E 03	2.15283E 03	2.18501E 03

Table F-94

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P10 WITH BOILING-WATER BATH

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
3.731499D 02	2.114800E 03	2.112496E 03	2.304199E 00	0
3.800098D 02	2.093500E 03	2.097047E 03	-3.546631E 00	1
3.996199D 02	2.049600E 03	2.048063E 03	1.536621E 00	2
4.288198D 02	1.961600E 03	1.961893E 03	-2.934570E-01	3

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 1.63631E 03

C_2 = 4.74021E-00

C_3 = -9.28399E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 4.509459E-00

d.f. = 1

t_α = 12.71

α = 0.05

Temperature (°K)	$\hat{\rho}$ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
370.	2.11930E 03	5.00516E 00	2.03367E 03	2.20492E 03	2.05568E 03	2.18291E 03
380.	2.09707E 03	2.89034E 00	2.02899E 03	2.16515E 03	2.06033E 03	2.13381E 03
390.	2.07298E 03	3.56826E 00	1.99990E 03	2.14607E 03	2.02763E 03	2.11834E 03
400.	2.04704E 03	4.25494E 00	1.96824E 03	2.12584E 03	1.99296E 03	2.10112E 03
410.	2.01924E 03	4.34128E 00	1.93969E 03	2.09880E 03	1.96407E 03	2.07442E 03
420.	1.98959E 03	3.83742E 00	1.91433E 03	2.06485E 03	1.94082E 03	2.03836E 03
430.	1.95808E 03	4.94080E 00	1.87306E 03	2.04310E 03	1.89528E 03	2.02088E 03

Table F-95

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P11 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
8.646999D 01	2.959700E 03	2.959522E 03	1.782227E-01	1
1.131600D 02	2.839200E 03	2.839617E 03	-4.167480E-01	2
1.547500D 02	2.666400E 03	2.665963E 03	4.367676E-01	3
1.876200D 02	2.539800E 03	2.540086E 03	-2.866211E-01	4
2.023000D 02	2.487200E 03	2.487111E 03	8.911133E-02	5

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 3.39344E 03

C_2 = -5.41971E-00

C_3 = 4.64460E-03

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 4.931027E-01

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.98958E 03	5.66408E-01	2.98636E 03	2.99281E 03	2.98715E 03	2.99202E 03
90.	2.94328E 03	4.13225E-01	2.94052E 03	2.94605E 03	2.94151E 03	2.94506E 03
100.	2.89791E 03	3.30966E-01	2.89536E 03	2.90046E 03	2.89649E 03	2.89933E 03
110.	2.85347E 03	3.19509E-01	2.85094E 03	2.85599E 03	2.85209E 03	2.85484E 03
120.	2.80995E 03	3.46927E-01	2.80736E 03	2.81255E 03	2.80846E 03	2.81145E 03
130.	2.76737E 03	3.78620E-01	2.76469E 03	2.77004E 03	2.76574E 03	2.76900E 03
140.	2.72571E 03	3.96388E-01	2.72299E 03	2.72843E 03	2.72401E 03	2.72742E 03
150.	2.68498E 03	3.93384E-01	2.68227E 03	2.68770E 03	2.68329E 03	2.68667E 03
160.	2.64518E 03	3.69276E-01	2.64254E 03	2.64783E 03	2.64360E 03	2.64677E 03
170.	2.60631E 03	3.30324E-01	2.60376E 03	2.60887E 03	2.60489E 03	2.60774E 03
180.	2.56837E 03	2.95385E-01	2.56590E 03	2.57085E 03	2.56710E 03	2.56964E 03
190.	2.53136E 03	3.03387E-01	2.52887E 03	2.53385E 03	2.53006E 03	2.53267E 03
200.	2.49528E 03	3.89557E-01	2.49258E 03	2.49798E 03	2.49360E 03	2.49695E 03

Table F-96

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P12 WITH LN_2 BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.7399990D 01	2.998100E 03	2.998516E 03	-4.165039E-01	0
8.6319990D 01	2.961500E 03	2.960823E 03	6.767578E-01	1
1.1320000D 02	2.843500E 03	2.843863E 03	-3.625488E-01	2
1.5470000D 02	2.664700E 03	2.664574E 03	1.262207E-01	3
2.0071000D 02	2.491200E 03	2.491222E 03	-2.197266E-02	4

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2 + C_4T^3$$

C_1 = 3.26341E 03

C_2 = -2.35980E-00

C_3 = -1.76936E-02

C_4 = 5.12308E-05.

Statistical Terms

$s_e = \sqrt{\Sigma(\text{Residuals})^2/\text{d.f.}}$

s_e = 8.827983E-01

d.f. = 1

t_α = 12.71

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.98761E 03	6.59850E-01	2.97361E 03	3.00162E 03	2.97923E 03	2.99600E 03
90.	2.94506E 03	6.04002E-01	2.93146E 03	2.95865E 03	2.93738E 03	2.95273E 03
100.	2.90172E 03	7.54576E-01	2.88696E 03	2.91648E 03	2.89213E 03	2.91131E 03
110.	2.85793E 03	8.09128E-01	2.84271E 03	2.87315E 03	2.84764E 03	2.86821E 03
120.	2.81397E 03	7.70665E-01	2.79908E 03	2.82887E 03	2.80418E 03	2.82377E 03
130.	2.77017E 03	7.11582E-01	2.75576E 03	2.78458E 03	2.76112E 03	2.77921E 03
140.	2.72682E 03	7.20693E-01	2.71233E 03	2.74130E 03	2.71766E 03	2.73598E 03
150.	2.68424E 03	8.14925E-01	2.66897E 03	2.69951E 03	2.67388E 03	2.69459E 03
160.	2.64273E 03	9.34677E-01	2.62638E 03	2.65907E 03	2.63085E 03	2.65461E 03
170.	2.60259E 03	9.98313E-01	2.59566E 03	2.61953E 03	2.58991E 03	2.61528E 03
180.	2.56415E 03	9.53458E-01	2.54764E 03	2.58067E 03	2.55203E 03	2.57627E 03
190.	2.52770E 03	8.17511E-01	2.51241E 03	2.54299E 03	2.51731E 03	2.53809E 03
200.	2.49355E 03	8.59965E-01	2.47789E 03	2.50922E 03	2.48262E 03	2.50448E 03
210.	2.46201E 03	1.50457E 00	2.43984E 03	2.48418E 03	2.44289E 03	2.48113E 03
220.	2.43339E 03	2.72408E 00	2.39699E 03	2.46978E 03	2.39877E 03	2.46801E 03
230.	2.40799E 03	4.45368E 00	2.35028E 03	2.46570E 03	2.35138E 03	2.46459E 03
240.	2.38612E 03	6.70972E 00	2.30010E 03	2.47214E 03	2.30084E 03	2.47140E 03
250.	2.36809E 03	9.53526E 00	2.24638E 03	2.48980E 03	2.24690E 03	2.48928E 03
260.	2.35421E 03	1.29821E 01	2.18832E 03	2.51959E 03	2.18920E 03	2.51921E 03
270.	2.34478E 03	1.71026E 01	2.12711E 03	2.56244E 03	2.12740E 03	2.56215E 03
280.	2.34011E 03	2.19519E 01	2.06087E 03	2.61934E 03	2.06110E 03	2.61911E 03
290.	2.34050E 03	2.75841E 01	1.98973E 03	2.69128E 03	1.98991E 03	2.69110E 03
300.	2.34628E 03	3.40542E 01	1.91330E 03	2.77925E 03	1.91345E 03	2.77911E 03

Table F-97

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P13 WITH LN_2 BATH

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
8.634999D 01	2.961500E 03	2.962365E 03	-8.649902E-01	1
1.135500D 02	2.841700E 03	2.839796E 03	1.903809E 00	2
1.537400D 02	2.670900E 03	2.672323E 03	-1.423096E 00	3
2.008500D 02	2.497100E 03	2.496714E 03	3.862305E-01	4

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 3.40083E 03

C_2 = -5.51232E-00

C_3 = 5.03305E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.558723E-00

d.f. = 1

t_α = 12.71

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.99205E 03	2.96269E 00	2.94230E 03	3.04181E 03	2.95440E 03	3.02971E 03
90.	2.94549E 03	2.15100E 00	2.90309E 03	2.98797E 03	2.91815E 03	2.97282E 03
100.	2.89992E 03	1.71743E 00	2.86076E 03	2.93909E 03	2.87810E 03	2.92175E 03
110.	2.85537E 03	1.66618E 00	2.81656E 03	2.89418E 03	2.83419E 03	2.87655E 03
120.	2.81182E 03	1.82577E 00	2.77187E 03	2.85178E 03	2.78862E 03	2.83503E 03
130.	2.76928E 03	2.01108E 00	2.72792E 03	2.81065E 03	2.74372E 03	2.79484E 03
140.	2.72775E 03	2.12805E 00	2.68545E 03	2.77005E 03	2.70070E 03	2.75480E 03
150.	2.68722E 03	2.14525E 00	2.64478E 03	2.72966E 03	2.65996E 03	2.71449E 03
160.	2.64770E 03	2.06913E 00	2.60589E 03	2.68952E 03	2.62142E 03	2.67399E 03
170.	2.60919E 03	1.93961E 00	2.56838E 03	2.65000E 03	2.58453E 03	2.63384E 03
180.	2.57168E 03	1.96091E 00	2.53147E 03	2.61189E 03	2.54803E 03	2.59533E 03
190.	2.53518E 03	1.99494E 00	2.49394E 03	2.57642E 03	2.50982E 03	2.56053E 03
200.	2.49968E 03	2.47236E 00	2.45446E 03	2.54491E 03	2.46826E 03	2.53111E 03
210.	2.46520E 03	3.29442E 00	2.41219E 03	2.51821E 03	2.42332E 03	2.50707E 03
220.	2.43172E 03	4.40374E 00	2.36698E 03	2.49645E 03	2.37574E 03	2.48769E 03
230.	2.39924E 03	5.75496E 00	2.31919E 03	2.47929E 03	2.32610E 03	2.47239E 03
240.	2.36777E 03	7.32238E 00	2.26919E 03	2.46636E 03	2.27471E 03	2.46084E 03
250.	2.33731E 03	9.09193E 00	2.21724E 03	2.45736E 03	2.22175E 03	2.45287E 03
260.	2.30786E 03	1.10560E 01	2.16362E 03	2.45209E 03	2.16734E 03	2.44838E 03
270.	2.27941E 03	1.32101E 01	2.10839E 03	2.45043E 03	2.11151E 03	2.44731E 03
280.	2.25197E 03	1.55513E 01	2.05165E 03	2.45228E 03	2.05431E 03	2.44963E 03
290.	2.22553E 03	1.80780E 01	1.99347E 03	2.45760E 03	1.99576E 03	2.45531E 03
300.	2.20011E 03	2.07890E 01	1.93389E 03	2.46633E 03	1.93588E 03	2.46433E 03

Table F-98

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P14 WITH BOILING-WATER BATH

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
3.731499D 02	2.032500E 03	2.032546E 03	-4.565430E-02	0
4.537798D 02	1.851800E 03	1.851391E 03	4.091797E-01	1
4.639399D 02	1.828200E 03	1.828563E 03	-3.632813E-01	2

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 2.87092E 03

C_2 = -2.24675E-00

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 5.490770E-01

d.f. = 1

t_α = 12.71

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
370.	2.03962E 03	5.67384E-01	2.02959E 03	2.04966E 03	2.03241E 03	2.04683E 03
380.	2.01716E 03	5.04542E-01	2.00768E 03	2.02663E 03	2.01074E 03	2.02357E 03
390.	1.99469E 03	4.46523E-01	1.98569E 03	2.00368E 03	1.98901E 03	2.00036E 03
400.	1.97222E 03	3.95459E-01	1.96362E 03	1.98082E 03	1.96719E 03	1.97725E 03
410.	1.94975E 03	3.54368E-01	1.94145E 03	1.95806E 03	1.94525E 03	1.95426E 03
420.	1.92729E 03	3.27028E-01	1.91916E 03	1.93541E 03	1.92313E 03	1.93144E 03
430.	1.90482E 03	3.17022E-01	1.89676E 03	1.91288E 03	1.90079E 03	1.90885E 03
440.	1.88235E 03	3.25947E-01	1.87423E 03	1.89047E 03	1.87821E 03	1.88649E 03
450.	1.85988E 03	3.52369E-01	1.85159E 03	1.86818E 03	1.85540E 03	1.86436E 03
460.	1.83742E 03	3.92771E-01	1.82883E 03	1.84600E 03	1.83242E 03	1.84241E 03

Table F-99

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: IML RUN P15 WITH BOILING-WATER BATH

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
3.731499D 02	1.984500E 03	1.982556E 03	1.944092E 00	0
3.999900D 02	1.920600E 03	1.925074E 03	-4.474365E 00	1
4.301699D 02	1.865800E 03	1.860440E 03	5.359619E 00	2
4.387200D 02	1.839300E 03	1.842129E 03	-2.829346E 00	3

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T$$

C_1 = 2.78171E 03

C_2 = -2.14163E-00

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 5.501369E-00

d.f. = 2

t_α = 4.30

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
370.	1.98930E 03	5.10256E 00	1.95704E 03	2.02157E 03	1.96736E 03	2.01124E 03
380.	1.96789E 03	4.24765E 00	1.93800E 03	1.99777E 03	1.94962E 03	1.98615E 03
390.	1.94647E 03	3.50717E 00	1.91842E 03	1.97452E 03	1.93139E 03	1.96155E 03
400.	1.92505E 03	2.96802E 00	1.89817E 03	1.95193E 03	1.91229E 03	1.93782E 03
410.	1.90364E 03	2.75124E 00	1.87719E 03	1.93009E 03	1.89181E 03	1.91547E 03
420.	1.88222E 03	2.92929E 00	1.85542E 03	1.90902E 03	1.86962E 03	1.89482E 03
430.	1.86080E 03	3.44140E 00	1.83290E 03	1.88871E 03	1.84601E 03	1.87560E 03
440.	1.83939E 03	4.16619E 00	1.80971E 03	1.86906E 03	1.82147E 03	1.85730E 03

Table F-100

SPECIMEN TEMPERATURE AND ELECTRICAL RESISTIVITY VS NEUTRON FLUENCE

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm
PRE5	Oct 12	0720	0	0		77.42	2.037	77.42	1.064	77.40	0.6752	77.40	2325.6	77.41	138.32
PRE4	Oct 12	2110	0	0		77.42	2.039	77.42	1.070	77.40	0.6785	77.40	2319.4	77.43	138.65
PRE1	Oct 13	0625	0	0		77.41	2.037	77.42	1.066	77.40	0.6787	77.40	2337.9	77.42	138.70
1	Oct 13	1852	6.95	1.242	.00027-.0007	110.59		113.37		109.61		117.69		161.88	
2	Oct 13	1905	6.95	2.748	.00059-.0015	112.37		113.91		110.13		118.98		169.02	
3	Oct 13	1910	6.95	3.327	.00072-.0019	112.53		114.32		110.31		119.08		170.11	
4	Oct 13	1940	6.95	6.802	.0015-.0038	112.71		114.93		111.00		120.13		171.90	
5	Oct 13	2007	5.0	9.573	.0021-.0054	105.84		106.59		103.61		110.55		154.86	
6	Oct 13	2020	5.0	10.656	.0023-.0060	105.50		106.94		103.78		110.33		151.80	
7	Oct 13	2037	5.0	12.073	.0026-.0068	105.21		106.40		103.63		109.98		150.69	
8	Oct 13	2101	5.0	14.072	.0030-.0079	105.01		106.20		103.44		109.77		150.32	
9	Oct 13	2110	5.0	14.822	.0032-.0083	104.94	2.345	106.20	1.225	103.40	0.8238	109.74	2175.9	149.90	146.72
10	Oct 13	2140	5.0	17.322	.0037-.0097	104.91	2.335	106.20	1.266	103.40	0.8188	109.74	2190.8	149.90	146.55
11	Oct 13	2320	5.0	25.656	.0055-.014	105.41	2.341	106.57	1.245	103.80	0.8302	110.76	2244.0	150.02	146.52
12	Oct 14	0040	4.4	32.446	.0070-.018	105.07		106.44		103.97		110.74		150.14	
13	Oct 14	0115	4.90	34.814	.0075-.020	105.27		106.77		103.89		110.89		150.43	
14	Oct 14	0210	4.90	39.306	.0085-.022	105.22		106.72		103.94		110.97		150.32	
15	Oct 14	0304	4.90	43.716	.0094-.025	105.16	2.331	106.52	1.235	104.05		111.12	2330.9	150.32	145.98
16	Oct 14	0408	4.90	48.942	.011-.028	105.10		106.57		104.22		110.49		150.30	
17	Oct 14	0501	4.90	53.271	.011-.030	105.07		106.74		104.05		111.29		150.18	
18	Oct 14	0554	4.90	57.599	.012-.032	105.06		106.91		104.15		110.58		150.69	
19	Oct 14	0700	4.90	62.989	.014-.035	104.84	2.339	106.57	1.225	103.99	0.8532	110.53	2418.7	149.94	146.84
20	Oct 14	0800	4.8	67.789	.015-.038	104.84		106.65		103.93		110.91		150.02	
21	Oct 14	0900	4.8	72.589	.016-.040	104.90		106.89		104.24		110.31		149.93	
22	Oct 14	1000	4.8	77.389	.017-.044	105.19	2.346	106.78	1.243	104.99	0.8489	110.63	2474.7	149.78	146.72
23	Oct 14	1400	4.8	91.776	.020-.051	104.72	2.342	106.66	1.230	104.39	0.8557	110.76	2531.4	150.12	146.71
24	Oct 14	1500	4.8	96.576	.020-.054	104.56	2.345	106.66	1.255	103.97	0.8503	110.71	2551.4	149.51	146.82
25	Oct 14	1600	4.8	101.38	.022-.057	104.59		107.07		104.12		111.06		149.55	
26	Oct 14	1700	4.8	106.18	.023-.060	104.54		106.86		104.10		110.97		149.45	
27	Oct 14	1800	4.8	110.98	.024-.062	104.44		106.61		104.17		110.83		148.86	
28	Oct 14	1900	4.8	115.78	.024-.065	104.22	2.345	106.31	1.254	103.94	0.8746	110.70	2614.3	148.78	146.53

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Exposure: MW-h	Exposure: $nvt^b \times 10^{18}$	Aluminum: °K	Aluminum: μΩ-cm	NBS Be: °K	NBS Be: μΩ-cm	WANL Be: °K	WANL Be: μΩ-cm	Graphite: °K	Graphite: μΩ-cm	Titanium: °K	Titanium: μΩ-cm
				Specimen Temperature[a] and Electrical Resistivity											
29	Oct 14	2000	4.8	120.58	.026-.068	104.10		106.33		104.02		110.71		148.33	
30	Oct 14	2100	4.8	125.38	.027-.070	104.58		106.88		104.45		111.56		148.97	
31	Oct 14	2200	4.8	130.19	.028-.073	104.46		106.65		104.39		111.51		149.12	
32	Oct 14	2300	4.8	134.98	.029-.076	104.53	2.344	106.79	1.275	104.56	0.8829	111.78	2701.5	149.73	147.59
33	Oct 15	0007	4.7	139.93	.030-.079	104.92		106.88		104.54		111.56		148.79	
34	Oct 15	0120	4.7	145.64	.031-.082	104.51		107.15		104.48		111.65		148.47	
35	Oct 15	0220	4.7	150.34	.032-.085	104.73		107.09		104.86		111.95		148.39	
36	Oct 15	0320	4.7	155.04	.033-.089	105.00	2.336	107.55	1.245	105.05	0.8958	112.35	2724.2	148.68	146.87
37	Oct 15	0420	4.7	159.74	.034-.090	104.57		107.16		104.82		112.19		149.63	
38	Oct 15	0525	4.7	164.84	.036-.093	104.80		107.26		105.09		112.34		149.84	
39	Oct 15	0625	4.7	169.54	.037-.095	104.64		107.48		104.99		112.30		149.69	
40	Oct 15	0725	4.6	174.20	.038-.098	104.16	2.330	106.36	1.287	104.24	0.8960	111.86	2773.1	148.40	146.25
41	Oct 15	0825	4.6	178.80	.039-.10	104.03		106.40		104.42		111.77		148.18	
42	Oct 15	0925	4.6	183.40	.040-.10	103.93		106.69		104.31		111.78		147.93	
43	Oct 15	1025	4.6	188.004	.040-.11	104.30		107.91		104.68		112.14		148.40	
44	Oct 15	1125	4.6	192.60	.042-.11	104.28	2.342	107.05	1.252	104.70	0.9041	112.21	2812.1	148.28	147.03
45	Oct 15	1230	4.6	197.59	.043-.11	104.40		107.05		104.64		112.27		148.60	
46	Oct 15	1325	4.6	201.80	.044-.11	104.14		106.89		104.76		112.33		148.20	
47	Oct 15	1425	4.6	206.40	.045-.12	104.24		107.18		104.82		112.71		148.77	
48	Oct 15	1525	4.6	211.00	.046-.12	104.40	2.351	107.03	1.275	104.78	0.9233	[illegible]12.49	2848.1	148.67	146.69
49	Oct 15	1625	4.6	215.60	.047-.12	104.27		107.09		104.82		112.86		148.72	
50	Oct 15	1725	4.6	220.20	.048-.12	104.42		107.26		104.93		112.98		148.69	
51	Oct 15	1825	4.6	224.80	.049-.13	104.46		107.22		105.01		112.99		148.77	
52	Oct 15	1925	4.6	229.40	.050-.13	104.44	2.370	107.35	1.258	105.04	0.9414	112.89	2881.3	148.72	146.23
53	Oct 15	2025	2.3	233.69	.050-.13	93.27		94.70		93.18		98.47		120.72	
54	Oct 15	2125	2.3	235.99	.051-.13	92.70		94.37		92.70		97.67		118.26	
55	Oct 15	2225	4.6	240.06	.052-.13	103.38		106.18		104.15		111.66		146.65	
56	Oct 15	2323	4.6	244.50	.053-.14	102.14	2.351	104.75	1.300	103.05	0.9293	110.67	2915.7	145.60	145.94
57	Oct 16	0030	4.6	249.64	.054-.14	103.77		106.41		104.57		112.25		147.42	
58	Oct 16	0133	4.6	254.47	.055-.14	103.50		106.61		104.60		112.35		147.48	
59	Oct 16	0235	4.6	259.23	.056-.15	103.78		106.62		104.61		112.57		147.71	
60	Oct 16	0335	4.6	263.83	.057-.15	104.08	2.352	106.62	1.311	104.61	0.9255	112.56	2931.3	148.35	147.59

[a]Temperatures were taken from T/C 2 on each specimen.
[b] Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure, MW-h	Exposure, nvt[b] x 10^{18}	Aluminum, °K	Aluminum, μΩ-cm	NBS Be, °K	NBS Be, μΩ-cm	WANL Be, °K	WANL Be, μΩ-cm	Graphite, °K	Graphite, μΩ-cm	Titanium, °K	Titanium, μΩ-cm
61	Oct 16	0438	4.6	268.66	.058-.15	104.17		107.16		104.93		113.32		148.50	
62	Oct 16	0534	4.6	272.95	.059-.15	104.15		107.39		105.17		113.31		148.74	
63	Oct 16	0534	4.6	272.95	.059-.15	104.05		106.85		105.13		112.91		148.20	
64	Oct 16	0630	4.6	277.24	.060-.16	103.96	2.331	107.03	1.302	104.96	0.9535	113.04	2967.8	148.11	146.40
65	Oct 16	0730	4.6	281.84	.061-.16	103.89		107.03		104.96		113.21		148.33	
66	Oct 16	0832	4.6	286.59	.062-.16	104.14		107.13		105.22		113.56		148.50	
67	Oct 16	0931	4.6	291.12	.063 .16	104.10		107.27		105.13		113.42		148.33	
68	Oct 16	1030	4.6	295.64	.064-.17	103.97	2.354	107.48	1.288	104.98	0.9716	113.63	2992.7	148.28	146.89
69	Oct 16	1130	4.6	300.24	.065-.17	104.02		107.45		105.19		113.56		148.44	
70	Oct 16	1330	4.7	309.44	.067-.17	104.33		107.85		105.64		114.03		148.86	
71	Oct 16	1540	7.2	321.91	.069-.18	115.42		120.72		117.61		130.51		176.50	
72	Oct 16	1550	7.2	323.09	.070-.18	115.74		121.06		118.04		130.59		176.70	
73	Oct 16	1600	7.2	314.73	.070-.18	115.82		120.81		117.87		130.80		177.55	
74	Oct 16	1635	7.2	328.38	.071-.18	116.18		121.83		118.58		131.45		178.90	
75	Oct 16	1705	7.2	331.91	.072-.19	116.61		122.49		118.95		132.52		179.97	
76	Oct 16	1732	7.2	335.15	.072-.19	115.75		122.26		119.18		132.31		179.72	
77	Oct 16	1800	7.2	338.51	.073-.19	116.53		121.57		118.82		132.04		179.99	
78	Oct 16	1901	7.2	345.83	.075-.19	116.61	2.500	122.54	1.494	119.30	1.097	132.61	2898.6	179.97	150.10
79	Oct 16	2005	7.2	353.51	.076-.20	116.61		122.10		118.91		132.28		179.41	
80	Oct 16	2100	7.2	360.11	.078-.20	116.81	2.554	122.49	1.439	118.99	1.114	132.62	2918.5	179.49	150.21
81	Oct 16	2205	7.2	367.91	.079-.21	116.72		112.15		119.19		132.65		180.00	
82	Oct 16	2300	7.2	378.11	.082-.21	113.39		120.81		118.73		132.00		178.35	
83	Oct 17	0030	7.2	385.31	.083-.22	116.76		122.47		119.50		132.83		180.23	
84	Oct 17	0130	7.2	392.51	.085-.22	117.03	2.511	121.90	1.436	119.09	1.121	132.84	2940.7	180.03	150.13
85	Oct 17	0230	7.2	399.71	.086-.22	117.03		122.16		119.68		133.36		180.78	
86	Oct 17	0330	7.2	406.91	.088-.23	117.31		122.16		119.46		133.24		180.03	
87	Oct 17	0430	7.2	414.11	.089-.23	117.28		123.14		119.84		133.56		180.12	
88	Oct 17	0530	7.2	421.31	.091-.24	117.20	2.513	123.22	1.474	120.02	1.133	133.66	2968.0	180.01	150.30
89	Oct 17	0630	7.2	428.51	.093-.24	117.07		122.99		119.77		133.62		180.60	
90	Oct 17	0730	7.2	435.71	.094-.24	117.22		123.15		120.11		134.12		180.96	
91	Oct 17	0830	7.2	442.91	.096-.25	117.28		123.54		119.47		134.62		181.48	
92	Oct 17	0930	7.2	450.11	.097-.25	117.04		122.85		119.36		133.75		180.85	

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Exposure MW-h	Exposure nvt[b] x 10^{18}	Aluminum °K	Aluminum μΩ-cm	NBS Be °K	NBS Be μΩ-cm	WANL Be °K	WANL Be μΩ-cm	Graphite °K	Graphite μΩ-cm	Titanium °K	Titanium μΩ-cm
93	Oct 17	1030	7.2	457.31	.099-.26	117.04	2.522	122.88	1.483	119.19	1.154	134.09	2985.8	180.96	150.48
94	Oct 17	1130	7.2	464.51	.10-.26	117.27		123.07		119.50		134.41		180.94	
95	Oct 17	1230	7.2	471.71	.10-.27	117.22		123.15		119.89		134.49		181.35	
96	Oct 17	1330	7.2	478.91	.10-.27	117.30	2.514	123.26	1.477	119.84	1.178	134.80	3006.4	181.27	150.93
97	Oct 17	1430	7.2	486.11	.10-.27	117.14		123.32		119.75		134.52		181.27	
98	Oct 17	1600	7.2	495.58	.11-.28	116.51		121.92		119.85		133.61		179.40	
99	Oct 17	1700	7.2	502.78	.11-.28	117.04		122.91		120.59		135.13		180.29	
100	Oct 17	1800	7.2	509.98	.11-.29	117.35		123.69		120.93		135.83		181.69	
101	Oct 17	1900	7.2	517.18	.11-.29	116.98	2.528	123.08	1.497	120.61	1.188	134.97	3024.9	180.73	150.15
102	Oct 17	2000	7.2	524.38	.11-.29	117.24		123.52		121.26		135.84		181.18	
103	Oct 17	2104	7.2	532.06	.11-.30	117.39		123.57		121.46		135.81		181.28	
104	Oct 17	2200	7.2	538.78	.12-.30	117.39		123.90		121.29		136.33		181.78	
105	Oct 17	2330	7.2	549.31	.12-.31	117.05		123.71		120.98		135.61		180.92	
106	Oct 18	0030	7.2	556.51	.12-.31	117.07		123.76		120.88		135.86		181.29	
107	Oct 18	0130	7.2	563.71	.12-.32	117.06	2.536	123.67	1.530	121.19	1.216	135.98	3044.7	181.59	150.64
108	Oct 18	0230	7.2	570.91	.12-.32	117.28		124.18		121.34		136.49		181.65	
109	Oct 18	0330	7.2	578.11	.12-.32	117.42		124.33		121.54		136.90		182.04	
110	Oct 18	0430	7.2	585.31	.13-.33	117.41		124.19		121.71		137.11		182.03	
111	Oct 18	0530	7.2	592.51	.13-.33	117.55	2.531	124.26	1.531	121.78	1.237	137.18	3061.8	182.42	150.84
112	Oct 18	0630	7.2	599.71	.13-.34	117.71		124.87		121.76		137.31		182.15	
113	Oct 18	0730	7.2	606.91	.13-.35	117.72		124.37		121.93		137.49		182.23	
114	Oct 18	0830	7.2	614.11	.13-.35	117.30		124.37		121.92		136.65		181.59	
115	Oct 18	0933	7.2	621.31	.14-.35	117.58	2.593	124.81	1.524	121.79	1.260	137.37	3076.3	182.04	151.11
116	Oct 18	1030	7.2	628.51	.14-.36	117.67		124.59		122.49		138.13		182.65	
117	Oct 18	1132	7.2	635.95	.14-.36	117.12		123.79		121.79		136.98		180.98	
118	Oct 18	1230	0	639.19	.14-.36	80.80		81.21		81.21		138.63		84.71	
119	Oct 18	1330	5.0	642.35	.14-.36	104.73	2.388	109.35	1.423	107.71	1.125	117.97	3157.6	149.96	147.21
120	Oct 18	1430	5.0	647.35	.14-.36	105.19		109.89		108.51		118.75		151.10	
121	Oct 18	1530	5.0	652.35	.14-.37	105.44		110.16		108.39		119.19		152.18	
122	Oct 18	1630	5.0	657.35	.14-.37	105.67		110.51		108.76		119.46		152.10	
123	Oct 18	1730	5.0	662.34	.14-.37	106.17	2.421	110.82	1.457	109.34	1.174	120.32	3150.3	153.22	147.51
124	Oct 18	1830	5.0	667.35	.14-.38	114.82		110.76		109.31		119.99		153.22	

Specimen Temperature[a] and Electrical Resistivity

[a]Temperatures were taken from T/C 2 on each specimen.

[b] Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure MW-h	Exposure nvt[b] x 10^{18}	Aluminum °K	Aluminum $\mu\Omega$-cm	NBS Be °K	NBS Be $\mu\Omega$-cm	WANL Be °K	WANL Be $\mu\Omega$-cm	Graphite °K	Graphite $\mu\Omega$-cm	Titanium °K	Titanium $\mu\Omega$-cm
125	Oct 18	1930	5.0	672.35	.14-.38	105.97		110.95		109.22		120.19		153.28	
126	Oct 18	2035	0.0	674.14	.15-.38	77.58		77.55		77.48		77.48		77.24	
127	Oct 18	2130	0	674.14	.15-.38	77.49		77.52		77.40		77.40		77.82	
128	Oct 19	0100	0	674.14	.15-.38	77.48	2.089	77.49	1.255	77.43	0.9562	77.33	3325.1	77.69	138.82
129	Oct 19	0637	0	674.14	.15-.38	77.48	2.091	77.47	1.263	77.42	0.9594	77.32	3326.6	77.65	139.33
130	Oct 19	1007	0	674.14	.15-.38	77.32	2.088	77.48	1.254	77.41	0.9603	77.33	3333.4	77.60	138.72
131	Oct 19	1345	0	674.14	.15-.38	77.48	2.090	77.47	1.253	77.41	0.9577	77.34	3324.3	77.59	138.83
132	Oct 19	1730	0	674.14	.15-.38	77.48	2.141	77.47	1.249	77.41	0.9564	77.34	3289.0	77.59	138.60
133	Oct 19	2230	7.2	686.98	.15-.39	114.79		122.19		119.99		135.27		176.02	
134	Oct 19	2330	7.2	694.18	.15-.39	115.44		122.82		120.39		136.18		177.35	
135	Oct 20	0030	7.2	698.94	.15-.39	115.14		122.48		120.12		135.29		178.29	
136	Oct 20	0130	7.2	705.94	.15-.40	115.78		123.07		121.18		136.78		178.29	
137	Oct 20	0225	7.2	712.54	.15-.40	115.93		122.88		121.27		136.76		178.52	
138	Oct 20	0330	6.7	719.84	.15-.40	114.72	2.509	121.85	1.545	118.85	1.259	134.06	3136.8	173.56	149.77
139	Oct 20	0430	6.7	726.54	.16-.41	114.54		121.82		118.97		133.79		174.21	
140	Oct 20	0530	6.7	733.24	.16-.41	114.41		121.39		118.88		134.01		174.26	
141	Oct 20	0630	6.7	739.94	.16-.42	114.78		122.04		119.65		134.68		174.63	
142	Oct 20	0730	6.7	746.64	.16-.42	114.80	2.531	122.42	1.563	119.81	1.281	134.89	3148.8	174.98	149.25
143	Oct 20	0830	6.7	753.34	.16-.42	114.92		122.26		119.91		135.31		175.05	
144	Oct 20	0930	6.7	760.04	.16-.43	114.51		122.11		119.68		134.63		174.34	
145	Oct 20	1130	7.2	770.69	.17-.43	113.74	2.471	120.64	1.574	118.98	1.258	133.98	3141.1	173.10	149.33
146	Oct 20	1242	7.0	779.45	.17-.44	113.21		120.53		118.50		133.36		171.79	
147	Oct 20	1530	7.0	782.91	.17-.44	111.83		119.17		117.15		131.54		168.34	
148	Oct 20	1730	7.0	789.14	.17-.44	112.20		119.19		117.46		132.25		168.91	
149	Oct 20	1830	7.0	795.745	.17-.45	112.84		120.74		118.39		133.27		170.64	
150	Oct 20	1930	7.0	802.54	.17-.45	113.09		120.50		118.86		133.79		170.64	
151	Oct 20	2030	7.0	809.34	.17-.46	113.36	2.492	120.94	1.534	118.94	1.283	134.29	3164.0	171.27	149.52
152	Oct 20	2130	7.0	816.14	.17-.46	113.59		120.87		119.00		134.38		172.24	

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm
153	Oct 20	2230	7.0	822.94	.18-.46	113.59		120.91		118.97		134.42		172.32	
154	Oct 20	2330	7.0	829.74	.18-.47	113.32		120.94		119.22		134.42		172.41	
155	Oct 21	0030	7.2	836.64	.18-.47	114.34	2.519	121.92	1.599	120.23	1.325	136.22	3180.5	174.74	149.99
156	Oct 21	0030	7.2	843.64	.18-.47	114.33		121.86		120.33		136.12		174.52	
157	Oct 21	0230	7.2	850.64	.18- 48	114.35		121.99		120.36		136.36		174.71	
158	Oct 21	0330	7.2	857.64	.18-.48	114.34		121.88		120.43		136.32		174.52	
159	Oct 21	0430	7.2	864.64	.19-.49	114.42	2.519	122.36	1.597	120.49	1.343	136.34	3190.3	174.94	150.09
160	Oct 21	0530	7.2	871.64	.19-.49	114.37		122.02		120.40		136.59		174.74	
161	Oct 21	0630	7.2	878.64	.19-.49	114.53		122.07		120.36		136.79		174.69	
162	Oct 21	0730	7.2	885.64	.19-.50	114.67		122.47		120.55		136.93		175.00	
163	Oct 21	0830	7.2	892.64	.19-.50	114.38	2.542	121.61	1.623	120.33	1.348	136.10	3188.5	174.22	149.90
164	Oct 21	1030	0	896.84	.19-.50	77.47		77.49		77.45		77.45		77.70	
165	Oct 21	1235	0	896.84	.19-.50	77.45	2.103	77.47	1.332	77.43	1.050	77.40	3385.5	77.59	138.83
166	Oct 21	1800	0	896.84	.19-.50	77.44	2.096	77.44		77.40	1.049	77.36	3375.8	77.50	138.74
167	Oct 21	2200	0	896.84	.19-.50	77.42	2.101	77.43	1.336	77.40	1.049	77.35	3376.0	77.47	138.79
168	Oct 22	0200	0	896.84	.19-.50	77.41	2.106	77.43	1.332	77.40	1.055	77.37	3376.7	77.47	138.92
169	Oct 22	0530	0	896.84	.19-.50	77.41	2.101	77.43	1.332	77.40	1.073	77.36	3379.8	77.45	138.84
170	Oct 22	0633	7.2	900.80	.19-.50	113.48		121.82		120.62		137.37		175.81	
171	Oct 22	0730	7.2	907.64	.20-.51	115.16		123.17		121.75		139.08		177.38	
172	Oct 22	0830	7.2	914.84	.20-.51	116.03		124.07		122.65		140.39		178.94	
173	Oct 22	0930	7.2	922.04	.20-.52	116.33	2.540	124.70	1.645	123.22	1.394	140.75	3183.1	179.85	150.30
174	Oct 22	1035	6.7	929.60	.20-.52	114.84		122.88		121.77		138.88		176.26	
175	Oct 22	1135	6.6	936.24	.20-.53	114.28		121.97		120.71		137.19		173.99	
176	Oct 22	1235	6.5	942.84	.20-.53	114.04		121.58							
177	Oct 22	1330	6.5	945.76	.20-.53	113.48	2.514	121.51	1.635	119.93	1.357	136.27	3192.6	171.34	152.08
178	Oct 22	1430	6.5	952.26	.21-.54	113.62		121.31		120.21		136.74		173.20	
179	Oct 22	1530	6.5	958.76	.21-.54	113.53		121.80		120.18		136.83		172.76	
180	Oct 22	1630	6.5	965.26	.21-.54	113.86		121.86		120.63		137.12		173.54	
181	Oct 22	1730	6.5	971.76	.21-.55	113.53	2.531	121.80	1.642	120.34	1.368	136.88	3195.3	173.12	150.02
182	Oct 22	1830	6.5	978.26	.21-.55	113.45		121.16		119.87		136.41		172.61	
183	Oct 22	1930	6.5	984.76	.21-.55	113.37		121.38		119.99		136.41		172.29	
184	Oct 22	2030	6.5	991.26	.21-.56	113.57		121.33		120.55		137.45		173.25	

[a] Temperatures were taken from T/C 2 on each specimen.
[b] Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt^{b} x 10^{18}	°K	$\mu\Omega$-cm	°K	$\mu\Omega$-cm	°K	$\mu\Omega$-cm	°K	$\mu\Omega$-cm	°K	$\mu\Omega$-cm
185	Oct 22	2130	6.5	997.76	.21-.56	114.42	2.533	122.56	1.667	121.17	1.396	138.70	3223.4	174.50	150.49
186	Oct 22	2230	6.5	1004.3	.22-.56	114.30		122.75		120.95		138.46		174.74	
187	Oct 22	2330	6.5	1010.8	.22-.57	113.96		122.17		121.05		137.92		173.88	
188	Oct 23	0030	7.2	1017.6	.22-.57	116.88		125.81		124.49		143.02		181.82	
189	Oct 23	0130	7.2	1024.8	.22-.58	116.23	2.549	124.80	1.696	123.63	1.446	141.96	3200.5	180.12	150.61
190	Oct 23	0230	7.2	1031.8	.22-.58	116.04		124.52		123.72		141.45		179.54	
191	Oct 23	0330	7.2	1038.8	.22-.58	116.36		125.12		123.83		142.14		180.45	
192	Oct 23	0430	7.2	1045.8	.23-.59	115.96		124.82		123.58		141.67		179.40	
193	Oct 23	0530	7.2	1052.8	.23-.59	115.89	2.550	124.77	1.690	123.37	1.437	141.45	3216.2	179.44	150.65
194	Oct 23	0630	6.6	1059.6	.23-.60	114.67		123.08		121.78		139.00		175.99	
195	Oct 23	0730	6.6	1066.3	.23-.60	114.67		123.04		121.97		139.19		176.17	
196	Oct 23	0830	6.6	1071.5	.23-.60	114.25		122.49		121.25		138.52		173.40	
197	Oct 23	0930	6.6	1078.2	.23-.61	114.64		123.10		122.03		139.40		176.19	
198	Oct 23	1030	6.6	1084.9	.23-.61	115.37	2.533	124.12	1.687	122.22	1.415	139.66	3219.6	176.44	150.28
199	Oct 23	1130	6.6	1091.6	.24-.61	115.07		123.92		122.16		139.50		176.17	
200	Oct 23	1245	6.4	1099.8	.24-.62	113.78		122.62		120.62		137.19		173.93	
201	Oct 23	1330	6.4	1104.6	.24-.62	113.84		122.61		120.89		137.44		174.08	
202	Oct 23	1430	6.4	1110.9	.24-.62	113.71	2.531	122.50	1.687	120.88	1.431	137.29	3243.1	173.71	149.51
203	Oct 23	1530	6.4	1117.4	.24-.63	113.52		122.05		120.48		136.75		173.07	
204	Oct 23	1630	6.4	1123.8	.24-.63	113.30		122.00		120.24		136.82		172.83	
205	Oct 23	1730	6.4	1130.2	.24-.64	113.40		121.95		120.35		136.75		172.69	
206	Oct 23	1830	6.4	1136.6	.24-.64	113.32	2.508	122.07	1.706	120.40	1.451	136.63	3244.2	172.66	150.32
207	Oct 23	1935	6.4	1143.5	.25-.64	113.37		122.01		120.46		137.03		172.71	
208	Oct 23	2030	6.4	1149.4	.25-.65	113.21		121.77		120.49		136.79		172.54	
209	Oct 23	2130	6.4	1155.8	.25-.65	113.43		122.23		120.45		137.13		172.81	
210	Oct 23	2230	6.4	1162.2	.25-.65	113.58	2.515	122.00	1.712	120.64	1.452	137.26	3249.1	173.00	150.16
211	Oct 23	2330	6.4	1168.6	.25-.66	113.16		122.09		120.78		137.00		172.92	
212	Oct 24	0030	6.4	1174.9	.25-.66	113.23		122.72		121.32		136.98		173.12	

[a]Temperatures were taken from T/C 2 on each specimen.

[b] Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm
213	Oct 24	0130	6.4	1181.4	.25-.66	113.31		121.99		120.75		136.87		173.07	
214	Oct 24	0230	6.4	1187.8	.26-.67	113.32	2.529	122.26	1.728	120.84	1.470	137.44	3251.4	173.18	150.21
215	Oct 24	0330	6.4	1194.2	.26-.67	113.46		122.68		120.89		137.30		172.79	
216	Oct 24	0430	6.4	1200.6	.26-.68	113.44		121.86		120.82		137.58		173.26	
217	Oct 24	0530	6.4	1206.9	.26-.68	113.00		121.57		120.47		136.59		172.44	
218	Oct 24	0630	6.4	1213.4	.26-.68	113.45	2.527	122.65	1.734	120.83	1.481	137.56	3248.8	173.01	150.02
219	Oct 24	0730	6.4	1219.8	.26-.69	113.70		122.62		121.27		138.05		173.26	
220	Oct 24	0830	6.4	1226.2	.26-.69	113.72		122.83		121.19		138.13		173.70	
221	Oct 24	0930	6.4	1232.6	.27-.69	113.51	2.526	122.75	1.742	121.18	1.490	137.87	3268.6	173.54	150.42
222	Oct 24	1030	6.4	1238.9	.27-.70	113.53		122.75		121.13		137.65		173.23	
223	Oct 24	1130	6.4	1245.4	.27-.70	113.65		122.75		121.20		137.90		173.50	
224	Oct 24	1230	6.4	1251.8	.27-.70	113.70		122.44		121.20		138.18		173.82	
225	Oct 24	1330	6.4	1258.1	.27-.71	113.71		122.86		121.30		138.13		173.74	
226	Oct 24	1430	6.4	1264.6	.27-.71	113.83	2.527	123.08	1.746	121.30	1.510	138.28	3258.8	173.74	149.88
227	Oct 24	1530	6.4	1270.9	.27-.72	113.81		122.52		121.72		138.60		173.98	
228	Oct 24	1630	6.4	1277.4	.28-.72	113.53		122.63		121.23		138.07		173.66	
229	Oct 24	1730	6.4	1283.8	.28-.72	113.48		122.89		121.51		138.22		173.48	
230	Oct 24	1830	6.4	1290.2	.28-.73	113.52	2.527	122.75	1.749	121.14	1.519	138.00	3281.7	173.20	150.57
231	Oct 24	1930	6.4	1296.6	.28-.73	113.53		122.44		121.36		138.28		173.25	
232	Oct 24	2030	6.4	1302.9	.28-.73	113.59		122.97		121.29		138.18		173.56	
233	Oct 24	2130	6.4	1309.4	.28-.74	113.45		122.36		121.08		137.92		173.21	
234	Oct 24	2225	6.4	1315.2	.28-.74	113.49	2.536	122.05	1.780	121.53	1.535	138.30	3274.3	173.28	150.33
235	Oct 24	2330	6.4	1322.2	.29-.74	113.64		122.58		121.68		138.27		173.92	
236	Oct 25	0030	6.4	1328.6	.29-.75	113.50		122.38		121.37		138.05		173.49	
237	Oct 25	0130	6.4	1335.0	.29-.75	113.40		122.61		121.44		138.24		173.60	
238	Oct 25	0230	6.4	1341.4	.29-.75	113.46	2.543	122.58	1.769	121.61	1.548	138.29	3270.2	173.64	150.10
239	Oct 25	0330	6.4	1347.8	.29-.76	113.40		122.94		121.49		138.13		173.34	
240	Oct 25	0430	6.4	1354.2	.29-.76	113.39		122.28		121.15		138.41		173.25	
241	Oct 25	0530	6.4	1360.6	.29-.77	113.38		122.58		120.74		137.91		173.28	
241A	Oct 25	0630	6.4	1366.9	.29-.77	113.54	2.547	122.87	1.802	121.84	1.544	138.76	3275.1	173.65	149.84
242	Oct 25	0730	6.4	1373.4	.30-.77	113.57		122.41		121.50		139.09		173.23	
243	Oct 25	0830	6.4	1379.8	.30-.78	113.48		122.72		121.51		138.66		173.10	

[a] Temperatures were taken from T/C 2 on each specimen.
[b] Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure, MW-h	Exposure, nvt[b] x 10^{18}	Aluminum, °K	Aluminum, $\mu\Omega$-cm	NBS Be, °K	NBS Be, $\mu\Omega$-cm	WANL Be, °K	WANL Be, $\mu\Omega$-cm	Graphite, °K	Graphite, $\mu\Omega$-cm	Titanium, °K	Titanium, $\mu\Omega$-cm
244	Oct 25	1930	6.4	1386.2	.30-.78	113.33		122.50		121.30		138.05		172.76	
245	Oct 25	1030	6.4	1392.6	.30-.78	113.18	2.535	122.53	1.768	121.69	1.553	138.51	3283.5	172.68	150.33
246	Oct 25	1130	6.4	1398.9	.30-.79	113.36		122.83		121.69		138.51		172.76	
247	Oct 25	1235	6.4	1405.9	.30-.79	113.33		122.83		121.69		138.51		172.72	
248	Oct 25	1330	6.4	1411.8	.30-.79	113.24		122.99		121.44		139.07		172.80	
249	Oct 25	1430	6.4	1418.2	.31-.80	113.57	2.540	123.10	1.817	122.16	1.574	139.07	3273.5	173.52	149.65
250	Oct 25	1530	6.4	1424.6	.31-.80	113.34		122.78		121.82		138.90		173.22	
251	Oct 25	1630	6.4	1430.9	.31-.81	113.57		123.36		121.74		138.76		173.62	
252	Oct 25	1730	6.4	1437.4	.31-.81	113.54		123.34		122.16		139.00		173.62	
253	Oct 25	1830	6.4	1443.8	.31-.81	113.55	2.537	123.12	1.830	122.08	1.580	139.22	3294.3	173.56	150.16
254	Oct 25	1930	6.4	1450.2	.31-.82	113.68		123.44		122.26		139.34		173.68	
255	Oct 25	2030	6.4	1456.6	.31-.82	113.52		123.45		121.89		139.48		173.93	
256	Oct 25	2130	6.4	1462.9	.32-.82	113.65		123.67		122.18		139.74		174.55	
257	Oct 25	2230	6.4	1469.4	.32-.83	113.62	2.547	123.20	1.843	122.12	1.599	139.40	3286.4	173.93	151.03
258	Oct 25	2330	6.4	1475.8	.32-.83	113.51		122.93		122.12		139.42		173.26	
259	Oct 26	0030	6.4	1482.2	.32-.83	113.77		123.49		122.35		139.76		174.23	
260	Oct 26	0130	6.4	1488.6	.32-.84	113.69		124.11		122.55		139.71		174.39	
261	Oct 26	0230	6.4	1495.0	.32-.84	113.76	2.553	124.82	1.860	122.45	1.605	140.21	3292.1	174.31	150.70
262	Oct 26	0330	6.4	1501.4	.32-.84	113.64		123.66		121.98		139.29		174.00	
263	Oct 26	0430	6.4	1507.8	.33-.85	113.52		123.22		122.01		139.19		173.62	
264	Oct 26	0530	6.4	1514.2	.33-.85	113.64		123.38		122.47		139.35		173.96	
265	Oct 26	0630	6.4	1520.6	.33-.86	113.78	2.542	123.52	1.846	122.39	1.618	140.03	3271.3	173.50	149.33
266	Oct 26	0730	6.4	1527.0	.33-.86	113.68		123.41		122.67		139.99		174.05	
267	Oct 26	0830	6.4	1533.4	.33-.86	113.83		123.60		122.58		140.43		174.05	
268	Oct 26	0930	6.4	1539.8	.33-.87	113.65		124.20		122.61		139.78		174.05	
269	Oct 26	1030	6.4	1546.2	.33-.87	113.54	2.543	123.99	1.865	122.33	1.624	139.78	3300.4	173.77	150.67
270	Oct 26	1130	6.4	1552.6	.33-.87	113.59		123.16		122.43		139.93		173.67	
271	Oct 26	1230	6.4	1558.9	.34-.88	113.61		123.19		122.15		140.03		173.01	
272	Oct 26	1330	6.4	1565.4	.34-.88	113.58		123.63		122.33		140.04		173.59	
273	Oct 26	1430	6.2	1571.7	.34-.88	112.69	2.536	121.94	1.860	121.13	1.613	138.20	3285.5	171.42	149.79
274	Oct 26	1530	6.2	1577.9	.34-.89	112.48		122.01		121.17		138.02		171.15	
275	Oct 26	1630	6.2	1584.1	.34-.89	112.55		122.34		121.32		138.37		171.29	

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Exposure MW-h	Exposure nvt[b] x 10^{18}	Aluminum °K	Aluminum μΩ-cm	NBS Be °K	NBS Be μΩ-cm	WANL Be °K	WANL Be μΩ-cm	Graphite °K	Graphite μΩ-cm	Titanium °K	Titanium μΩ-cm
						Specimen Temperature[a] and Electrical Resistivity									
276	Oct 26	1730	6.2	1590.2	.34-.89	112.80		122.49		121.40		138.79		171.64	
277	Oct 26	1830	6.2	1596.5	.34-.90	112.71	2.520	122.50	1.879	121.52	1.646	138.61	3294.1	171.33	149.59
278	Oct 26	1930	6.2	1602.7	.35-.90	113.02		122.66		121.31		138.19		171.63	
279	Oct 26	2030	6.2	1608.9	.35-.91	113.31		122.75		121.75		138.69		171.86	
280	Oct 26	2130	6.2	1615.1	.35-.91	113.09		122.83		121.86		139.14		172.14	
281	Oct 26	2230	6.2	1621.3	.35-.91	114.38	2.538	123.63	1.892	122.12	1.658	139.47	3298.0	172.45	149.91
282	Oct 26	2330	6.2	1627.3	.35-.92	113.49		122.69		122.06		139.32		172.31	
283	Oct 27	0030	6.2	1633.7	.35-.92	113.82		123.55		121.79		139.36		172.22	
284	Oct 27	0130	6.2	1639.9	.35-.92	114.03		123.16		121.86		139.14		173.49	
285	Oct 27	0230	6.2	1646.1	.36-.93	112.64	2.543	122.67	1.888	121.69	1.658	138.61	3314.7	171.91	150.13
286	Oct 27	0330	6.2	1652.3	.36-.93	112.72		122.35		122.00		138.94		172.14	
287	Oct 27	0430	6.2	1658.5	.36-.93	112.70		123.21		121.90		139.25		171.73	
288	Oct 27	0530	6.2	1664.7	.36-.94	112.92		124.06		122.43		139.34		172.28	
289	Oct 27	0630	6.2	1670.9	.36-.94	112.78	2.550	122.47	1.896	121.86	1.673	138.69	3313.2	171.83	149.87
290	Oct 27	0730	6.4	1677.2	.36-.94	113.71		123.79		122.97		140.93		174.03	
291	Oct 27	0830	6.4	1683.6	.36-.95	113.76		123.91		123.08		141.09		174.02	
292	Oct 27	0930	6.4	1690.0	.36-.95	113.80		123.96		123.05		141.09		174.25	
293	Oct 27	1030	6.4	1696.4	.37-.95	113.51	2.555	123.41	1.924	122.78	1.691	140.36	3317.3	173.78	150.55
294	Oct 27	1330	6.4	1707.8	.37-.96	112.29		121.91		121.18		138.42		170.19	
295	Oct 27	1430	6.4	1714.2	.37-.96	113.01		123.02		122.36		139.75		172.09	
296	Oct 27	1530	6.4	1720.6	.37-.97	113.10		123.62		122.65		139.85		172.71	
297	Oct 27	1630	6.4	1727.0	.37-.97	113.33	2.553	123.91	1.930	122.93	1.702	140.19	3317.9	172.96	150.48
298	Oct 27	1730	6.4	1733.4	.37-.98	113.72		124.36		123.11		141.15		174.33	
299	Oct 27	1830	6.4	1739.8	.38-.98	113.50		123.94		123.02		141.07		173.90	
300	Oct 27	1930	6.4	1746.2	.38-.98	113.86		124.51		123.06		141.29		174.04	
301	Oct 27	2030	6.4	1752.6	.38-.99	113.79	2.565	124.63	1.949	123.34	1.712	141.23	3310.3	174.18	150.46
302	Oct 27	2130	6.4	1759.0	.38-.99	113.83		123.86		123.10		141.24		175.09	
303	Oct 27	2230	6.4	1765.4	.38-.99	113.70		124.03		123.28		141.28		174.34	
304	Oct 27	2330	6.4	1771.8	.38-1.00	113.62		124.95		123.47		141.20		174.64	
305	Oct 28	0030	6.4	1778.2	.38-1.00	113.55	2.574	124.44	1.968	123.38	1.710	141.36	3291.3	174.48	149.37
306	Oct 28	0130	6.4	1784.6	.38-1.00	113.68		124.44		123.59		141.17		174.52	
307	Oct 28	0230	6.4	1791.0	.39 1.01	113.58		124.01		123.50		141.57		174.38	

[a]Temperatures were taken from T/C 2 on each specimen.
[b] Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm
308	Oct 28	0330	6.4	1797.4	.39-1.01	113.63	2.564	124.24	1.946	123.57	1.731	141.45		174.54	149.91
309	Oct 28	0430	6.4	1803.8	.39-1.02	113.71		124.03		123.78		141.47		174.54	
310	Oct 28	0530	6.4	1810.2	.39-1.02	113.48		123.93		123.46		141.32		173.98	
311	Oct 28	0630	6.4	1816.6	.39-1.02	113.28		124.29		123.50		141.18		173.98	
312	Oct 28	0730	6.4	1823.0	.39-1.03	113.55	2.561	124.18	1.968	123.20	1.729	140.97	3310.5	174.02	149.59
313	Oct 28	0830	6.4	1829.4	.39-1.03	113.62		123.94		123.57		141.53		174.06	
314	Oct 28	0930	6.4	1835.8	.40-1.03	113.53		123.63		123.08		141.21		173.72	
315	Oct 28	1030	6.4	1842.2	.40-1.04	113.11		123.58		122.79		140.28		173.03	
316	Oct 28	1130	6.4	1848.6	.40-1.04	113.52	2.578	123.98	1.969	123.23	1.755	141.67	3312.2	173.51	150.02
317	Oct 28	1230	6.4	1855.0	.40-1.04	113.50		124.05		123.36		142.23		173.41	
318	Oct 28	1330	6.4	1861.4	.40-1.05	113.68		124.32		123.42		142.26		173.86	
319	Oct 28	1430	6.4	1867.8	.40-1.05	113.70		124.43		123.71		141.34		174.02	
320	Oct 28	1530	6.4	1874.2	.40-1.06	113.52	2.562	124.14	1.985	123.66	1.747	141.39	3319.6	173.80	150.48
321	Oct 28	1630	6.4	1880.6	.4	113.16		124.12		122.98		140.61		172.91	
322	Oct 28	1730	6.4	1887.0	.41-1.06	113.14		123.87		122.99		140.69		172.61	
323	Oct 28	2130	0	1887.0	.41-1.06	77.47	2.163	77.52	1.688	77.46	1.432	77.40	3482.8	77.65	139.37
324	Oct 29	0130	0	1887.0	.41-1.06	77.40	2.163	77.44	1.662	77.47	1.421	77.48	3488.0	77.40	138.32
325	Oct 29	0530	0	1887.0	.41-1.06	77.21	2.157	77.24	1.688	77.18	1.421	77.10	3469.1	77.51	138.67
326	Oct 29	0934	0	1887.0	.41-1.06	77.42	2.158	77.46	1.688	77.41	1.423	77.37	3462.1	77.51	138.61
327	Oct 29	1330	0	1887.0	.41-1.06	77.41	2.158	77.43	1.684	77.41	1.424	77.38	3458.9	77.48	138.59
328	Oct 29	1730	0	1887.0	.41-1.06	77.40	2.149	77.46	1.682	77.41	1.428	77.37	3462.1	77.46	138.98
329	Oct 29	2130	0	1887.0	.41-1.06	77.48	2.151	77.50	1.680	77.40	1.426	75.11	3489.0	77.66	139.28
330	Oct 31	0200	0	1887.0	.41-1.06	77.40	2.158	77.40	1.699	77.40	1.439	77.40	3487.5	77.42	139.73
331	Oct 31	0600	0	1887.0	.41-1.06	77.40	2.171	77.40	1.697	77.40	1.429	77.40	3487.9	77.41	139.56
332	Oct 31	0800	0	1887.0	.41-1.06	77.43		77.44		77.40		77.44		77.49	
333	Oct 31	0930	5.0	1900.8	.41-1.07	108.88		111.41		111.15		123.92		149.65	
334	Oct 31	1030	5.0	1905.8	.41-1.07	104.52		112.42		112.04		125.38		150.57	
335	Oct 31	1130	5.0	1910.8	.41-1.08	105.06		113.37		112.84		126.14		152.23	
336	Oct 31	1230	5.0	1915.8	.41-1.08	105.29	2.465	113.37	1.913	112.95	1.658	126.65	3360.0	151.99	148.36
337	Oct 31	1330	5.0	1920.8	.41-1.08	105.55		113.88		113.15		126.71		153.14	
338	Oct 31	1430	5.0	1925.8	.42-1.08	105.68		113.95		113.54		127.04		153.53	
339	Oct 31	1530	5.0	1930.8	.42-1.09	105.60		114.12		113.43		127.12		153.12	

[a]Temperatures were taken from T/C 2 on each specimen.

[b]Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity											
				Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm
340	Oct 31	1630	5.0	1935.8	.42-1.09	105.94	2.470	114.44	1.930	113.86	1.694	127.27	3350.6	153.11	147.99
341	Oct 31	1730	5.0	1940.8	.42-1.09	106.05		114.26		113.65		127.32		153.34	
342	Oct 31	1830	5.0	1945.8	.42-1.10	105.89		114.13		113.56		126.86		153.00	
343	Oct 31	1930	5.0	1950.8	.42-1.10	105.93		114.01		113.58		127.12		153.22	
344	Oct 31	2030	5.0	1955.8	.42-1.10	105.94	2.480	114.54	1.925	113.35	1.682	126.87	3377.8	152.89	148.59
345	Oct 31	2130	5.0	1960.8	.42-1.10	105.88		114.32		114.31		127.45		153.94	
346	Oct 31	2230	5.0	1965.8	.42-1.11	105.97		114.67		113.87		127.57		154.09	
347	Oct 31	2330	5.0	1970.8	.43-1.11	105.68		114.44		113.73		127.31		153.75	
348	Nov 1	0030	5.0	1975.8	.43-1.11	105.85	2.591	114.60	1.943	113.82	1.687	125.77	3365.9	154.11	148.40
349	Nov 1	0130	5.0	1980.8	.43-1.12	105.05		113.74		113.15		126.18		152.49	
350	Nov 1	0230	5.0	1985.8	.43-1.12	105.90		114.67		113.67		127.45		153.98	
351	Nov 1	0330	5.0	1990.8	.43-1.12	105.86		114.15		113.75		127.18		153.95	
352	Nov 1	0430	5.0	1995.8	.43-1.12	105.90	2.487	114.58	1.949	113.95	1.702	127.36	3366.5	153.96	148.60
353	Nov 1	0530	5.0	2000.8	.43-1.13	105.82		114.55		113.63		127.17		153.55	
354	Nov 1	0630	5.0	2005.8	.43-1.13	106.03		114.87		114.20		127.57		154.24	
355	Nov 1	0730	5.0	2010.8	.43-1.13	106.17		114.71		114.25		127.88		154.40	
356	Nov 1	0830	5.0	2015.8	.43-1.13	106.06	2.487	114.74	1.956	114.15	1.713	127.77	3374.2	154.27	148.61
357	Nov 1	0930	5.0	2020.8	.44-1.14	106.24		114.81		114.41		127.98		154.68	
358	Nov 1	1030	5.0	2025.8	.44-1.14	106.25		115.20		114.46		128.28		154.92	
359	Nov 1	1130	5.0	2030.8	.44-1.14	106.18		114.90		114.60		127.95		154.56	
360	Nov 1	1230	5.0	2035.8	.44-1.15	106.16	2.495	114.77	1.960	114.27	1.722	128.27	3380.7	154.72	148.59
361	Nov 1	1330	5.0	2040.8	.44-1.15	106.06		114.35		114.01		127.76		154.20	
362	Nov 1	1430	5.0	2045.8	.44-1.15	106.34		115.12		114.27		128.29		154.87	
363	Nov 1	1530	5.0	2050.8	.44-1.15	106.20		114.96		114.47		128.10		154.73	
364	Nov 1	1630	5.0	2055.8	.44-1.16	106.31	2.517	114.94	1.969	114.47	1.720	128.14	3361.8	155.01	148.23
365	Nov 1	1730	5.0	2060.8	.44-1.16	106.46		115.25		114.63		128.29		155.20	
366	Nov 1	1830	5.0	2065.8	.45-1.17	106.35		115.38		114.82		128.50		155.30	
367	Nov 1	1930	5.0	2070.8	.45-1.17	106.22		114.79		114.44		128.31		154.60	
368	Nov 1	2030	5.0	2075.8	.45-1.17	106.81	2.494	115.31	1.929	114.51	1.732	128.49	3387.4	154.81	148.63
369	Nov 1	2130	5.0	2080.8	.45-1.17	107.17		115.29		114.39		128.19		154.63	
370	Nov 1	2230	5.0	2085.8	.45-1.17	106.35		115.40		114.58		128.28		115.17	
371	Nov 1	2330	5.0	2090.8	.45-1.18	106.10		114.71		113.98		127.98		155.05	

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minim__ and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity											
				Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	µΩ-cm	°K	µΩ-cm	°K	µΩ-cm	°K	µΩ-cm	°K	µΩ-cm
372	Nov 2	0030	5.0	2095.8	.45-1.18	106.10	2.484	114.88	1.984	114.36	1.742	127.87	3374.5	154.85	147.89
373	Nov 2	0130	5.0	2100.8	.45-1.18	106.08		115.11		114.60		128.16		154.67	
374	Nov 2	0230	5.0	2105.8	.45-1.19	106.02		115.15		114.52		128.15		154.90	
375	Nov 2	0330	5.0	2110.8	.46-1.19	106.23		115.32		114.89		128.43		155.05	
376	Nov 2	0430	5.0	2115.8	.46-1.19	106.23	2.492	115.30	1.997	114.61	1.753	127.90	3379.9	154.86	148.44
376A	Nov 2	0530	5.0	2120.8	.46-1.19	106.29		115.23		114.56		127.97		154.95	
377	Nov 2	0630	5.0	2125.8	.46-1.20	106.35		115.19		114.56		128.31		115.13	
378	Nov 2	0730	5.0	2130.8	.46-1.20	106.21		115.35		114.62		128.12		154.92	
379	Nov 2	0830	5.0	2135.8	.46-1.20	106.29	2.499	115.23	2.004	114.50	1.764	128.57	3394.6	154.76	148.18
380	Nov 2	0930	5.0	2140.8	.46-1.21	106.33		115.21		114.47		128.41		154.61	
381	Nov 2	1030	5.0	2145.8	.46-1.21	106.39		115.13		114.71		128.43		154.87	
382	Nov 2	1130	5.0	2150.8	.46-1.21	106.30		115.03		114.80		128.36		154.84	
383	Nov 2	1230	5.0	2155.8	.47-1.21	106.42		115.60		114.80		128.49		155.03	
384	Nov 2	1330	5.0	2160.8	.47-1.22	106.37		115.34		115.08		128.34		154.69	
385	Nov 2	1430	5.0	2165.8	.47-1.22	106.29		115.60		114.76		128.53		154.82	
386	Nov 2	1530	5.0	2170.8	.47-1.22	106.39		115.60		114.80		128.20		154.78	
387	Nov 2	1630	5.0	2175.8	.47-1.22	106.41	2.498	115.51	2.004	114.85	1.776	128.39	3386.3	154.76	148.11
388	Nov 2	1730	5.0	2180.8	.47-1.23	106.29		114.90		114.41		128.32		154.22	
389	Nov 2	1830	5.0	2185.8	.47-1.23	106.34		115.14		114.83		128.27		154.57	
390	Nov 2	1930	5.0	2190.8	.47-1.23	106.27		115.20		114.88		128.37		154.73	
391	Nov 2	2030	5.0	2195.8	.47-1.24	106.17	2.491	115.11	2.020	114.63	1.788	128.30	3402.4	154.65	148.89
392	Nov 2	2130	5.0	2200.8	.47-1.24	106.27		115.28		114.82		128.39		155.06	
393	Nov 2	2230	5.0	2205.8	.48-1.24	106.27		115.65		114.72		128.59		155.01	
394	Nov 2	2300	5.0	2210.8	.48-1.24	106.29		115.37		115.01		128.63		155.15	
395	Nov 3	0030	5.0	2213.3	.48-1.25	106.28	2.505	115.64	2.022	115.06	1.783	128.48	3386.5	155.01	148.92
396	Nov 3	0130	5.0	2220.8	.48-1.25	106.35		115.40		115.05		128.48		155.29	
397	Nov 3	0230	5.0	2225.8	.48-1.25	106.40		115.48		114.71		128.91		155.42	
398	Nov 3	0330	5.0	2230.8	.48-1.26	106.43		115.55		115.29		128.81		155.49	
399	Nov 3	0430	5.0	2235.8	.48-1.26	106.31	2.507	115.79	2.044	115.01	1.798	128.60	3392.9	155.27	148.61
400	Nov 3	0530	5.0	2240.8	.48-1.26	106.42		115.69		115.38		128.81		155.16	
401	Nov 3	0630	5.0	2245.8	.48-1.26	106.55		115.40		115.10		129.09		155.45	
402	Nov 3	0730	5.0	2250.8	.49-1.27	106.50		115.71		115.00		128.92		155.12	

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minimum and maximum neutron fluence for all specimens.

Table F-100 (Cont'd)

Run No.	Date (1967)	Time	Reactor Power (MW)	Specimen Temperature[a] and Electrical Resistivity: Exposure		Aluminum		NBS Be		WANL Be		Graphite		Titanium	
				MW-h	nvt[b] x 10^{18}	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm	°K	μΩ-cm
403	Nov 3	0830	5.0	2255.8	.49-1.27	106.48	2.497	115.61	2.046	115.15	1.813	129.13	3393.2	155.25	148.86
404	Nov 3	0930	5.0	2260.8	.49-1.27	106.50		115.42		115.11		128.94		155.40	
405	Nov 3	1030	5.0	2265.8	.49-1.28	106.35		115.63		115.01		129.05		155.35	
406	Nov 3	1130	5.0	2269.8	.49-1.28	106.39		115.46		114.70		128.86		154.61	
407	Nov 3	1230	5.0	2274.8	.49-1.28	106.29	2.510	115.64	2.049	114.87	1.819	128.64	3405.8	154.72	148.56
408	Nov 3	1330	5.0	2279.8	.49-1.28	106.50		115.66		115.20		128.80		155.03	
409	Nov 3	1430	5.0	2284.8	.49-1.29	106.49		115.79		115.23		128.88		155.11	
410	Nov 3	1530	5.0	2289.8	.49-1.29	106.55		115.87		115.27		128.99		155.47	
411	Nov 3	1630	5.0	2294.8	.50-1.29	106.50	2.512	115.46	2.068	115.04	1.824	129.05	3397.3	155.24	148.45
412	Nov 3	1800	5.0	2302.3	.50-1.30	106.66	2.504	116.08	2.061	115.24	1.828	129.12	3410.4	155.48	149.03
413	Nov 3	1950	0	Post		77.44	2.196	77.49	1.847	77.46	1.583	77.46	3521.4	77.68	139.33
414	Nov 3	2330	0	Post		77.45	2.194	77.46	1.848	77.45	1.583	77.40	3537.3	77.56	139.55
415	Nov 4	0330	0	Post		77.41	2.184	77.44	1.843	77.41	1.580	77.36	3520.6	77.49	139.52
416	Nov 4	0730	0	Post		77.40	2.176	77.42	1.837	77.40	1.577	77.38	3539.1	77.48	139.74
417	Nov 4	1130	0	Post		77.47	2.193	77.51	1.841	77.40	1.578	74.33	3524.3	77.73	139.60
418	Nov 4	1530	0	Post		77.49	2.185	77.53	1.836	77.41	1.576	72.15	3535.8	77.85	139.06
419	Nov 4	1930	0	Post		77.48	2.185	77.49	1.836	77.40	1.571	71.74	3521.0	77.86	139.29
420	Nov 4	2350	0	Post		77.48	2.186	77.47	1.845	77.40	1.580	72.06	3537.2	77.80	139.53
421	Nov 5	0400	0	Post		77.46	2.190	77.46	1.845	77.40	1.586	72.69	3535.9	77.77	139.59
422	Nov 5	0800	0	Post		77.46	2.183	77.46	1.841	77.40	1.580	73.22	3525.6	77.73	139.59
423	Nov 5	1200	0	Post		77.48	2.190	77.46	1.848	77.42	1.587	73.84	3534.7	77.72	140.33
424	Nov 5	1600	0	Post		77.48	2.185	77.44	1.840	77.40	1.574	74.35	3519.2	77.70	139.23

[a]Temperatures were taken from T/C 2 on each specimen.
[b]Minimum and maximum neutron fluence for all specimens.

APPENDIX G

ELECTRICAL RESISTIVITY TEST 37/R201 CALCULATED DATA

Tables G-1 through G-55 contain the data and calculations for ρ and $\Delta\rho$. The "Input Data" were processed by an IBM 360 computer. The methods used to process the data and definitions of the statistical terms are presented in Section III.

A general rule to follow to determine a reasonable number of significant digits that are applicable to the various values listed in the following tables is to make a relative comparison between teh value considered and its respective confidence limit. For example, a value of $\rho = 1.4996$ μohm-cm may be accurate to five significant digits, but with a confidence interval of 1.4938 and 1.5053 μohm-cm, ρ might well be limited to 1.500 $\pm$ 0.006 μohm-cm so far as inferences about the final results are concerned.

The data listed in the IBM E format is interpreted as follows:

$$1.55200\text{E } 02 = 1.552 \times 10^2$$
$$1.55200\text{E-}02 = 1.552 \times 10^{-2}$$

Table G-1

ELECTRICAL RESISTIVITY OF TITANIUM: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^{o}K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.552000E 02	1.548783E 02	3.217010E-01	1
9.650000D 01	1.575000E 02	1.577012E 02	-2.012024E-01	2
1.180000D 02	1.606000E 02	1.607887E 02	-1.886749E-01	3
1.410000D 02	1.638000E 02	1.639858E 02	-1.858521E-01	4
1.700000D 02	1.678000E 02	1.678613E 02	-6.134033E-02	5
2.020000D 02	1.724000E 02	1.719362E 02	4.638367E-01	6
2.265000D 02	1.749000E 02	1.749130E 02	-1.301575E-02	7
2.525000D 02	1.780000E 02	1.779365E 02	6.346130E-02	8
2.785000D 02	1.805000E 02	1.808204E 02	-3.204346E-01	9
2.950000D 02	1.827000E 02	1.825782E 02	1.218262E-01	10

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.42668E 02

C_2 = 1.65753E-01

C_3 = -1.03266E-04

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.815103E-01

d.f. = 7

t_α = 2.36

α = 0.05

Temperature (^{o}K)	ρ (μohm-cm)	$s_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.55267E 02	2.01005E-01	1.54451E 02	1.56083E 02	1.54793E 02	1.55741E 02
90.	1.56749E 02	1.68749E-01	1.55974E 02	1.57524E 02	1.56351E 02	1.57147E 02
100.	1.58210E 02	1.44382E-01	1.57464E 02	1.58957E 02	1.57870E 02	1.58551E 02
110.	1.59651E 02	1.28621E-01	1.58921E 02	1.60381E 02	1.59347E 02	1.59955E 02
120.	1.61071E 02	1.21261E-01	1.60348E 02	1.61794E 02	1.60785E 02	1.61357E 02
130.	1.62470E 02	1.20711E-01	1.61748E 02	1.63193E 02	1.62186E 02	1.62755E 02
140.	1.63849E 02	1.24468E-01	1.63123E 02	1.64576E 02	1.63555E 02	1.64143E 02
150.	1.65207E 02	1.30084E-01	1.64475E 02	1.65939E 02	1.64900E 02	1.65514E 02
160.	1.66545E 02	1.35719E-01	1.65807E 02	1.67282E 02	1.66224E 02	1.66865E 02
170.	1.67861E 02	1.40184E-01	1.67119E 02	1.68604E 02	1.67530E 02	1.68192E 02
180.	1.69157E 02	1.42793E-01	1.68412E 02	1.69902E 02	1.68820E 02	1.69494E 02
190.	1.70433E 02	1.43221E-01	1.69687E 02	1.71178E 02	1.70095E 02	1.70771E 02
200.	1.71688E 02	1.41434E-01	1.70944E 02	1.72431E 02	1.71354E 02	1.72021E 02
210.	1.72922E 02	1.37662E-01	1.72182E 02	1.73661E 02	1.72597E 02	1.73247E 02
220.	1.74135E 02	1.32483E-01	1.73401E 02	1.74870E 02	1.73823E 02	1.74448E 02
230.	1.75328E 02	1.26909E-01	1.74599E 02	1.76057E 02	1.75029E 02	1.75628E 02
240.	1.76500E 02	1.22568E-01	1.75776E 02	1.77225E 02	1.76211E 02	1.76790E 02
250.	1.77652E 02	1.21712E-01	1.76928E 02	1.78376E 02	1.77365E 02	1.77939E 02
260.	1.78783E 02	1.26891E-01	1.78054E 02	1.79511E 02	1.78483E 02	1.79082E 02
270.	1.79893E 02	1.40020E-01	1.79151E 02	1.80635E 02	1.79563E 02	1.80223E 02
280.	1.80983E 02	1.61745E-01	1.80216E 02	1.81749E 02	1.80601E 02	1.81364E 02
290.	1.82051E 02	1.91580E-01	1.81248E 02	1.82855E 02	1.81599E 02	1.82504E 02
300.	1.83100E 02	2.28639E-01	1.82244E 02	1.83956E 02	1.82560E 02	1.83639E 02

Table G-2

ELECTRICAL RESISTIVITY OF TITANIUM: POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	1.569000E 02	1.567387E 02	1.612549E-01	1
9.750000D 01	1.595000E 02	1.594438E 02	5.621338E-02	2
1.105000D 02	1.608000E 02	1.611647E 02	-3.641815E-01	3
1.450000D 02	1.657000E 02	1.656188E 02	8.119202E-02	4
1.740000D 02	1.693000E 02	1.692386E 02	6.143188E-02	5
1.960000D 02	1.720000E 02	1.719086E 02	9.143066E-02	6
2.215000D 02	1.750000E 02	1.749213E 02	7.868958E-02	7
2.565000D 02	1.786000E 02	1.789130E 02	-3.130341E-01	8
2.710000D 02	1.804000E 02	1.805181E 02	-1.181183E-01	9
2.960000D 02	1.834000E 02	1.832186E 02	1.813912E-01	10
3.260000D 02	1.864000E 02	1.863474E 02	5.255127E-02	11
3.665000D 02	1.905000E 02	1.903780E 02	1.220093E-01	12
4.190000D 02	1.952000E 02	1.952720E 02	-7.203674E-02	13
4.610000D 02	1.989000E 02	1.989184E 02	-1.843262E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.458111E 02

C_2 = -1.464266E-01

C_3 = -6.773608E-05

Statistical Terms

$s_e = \sqrt{\Sigma(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.795770E-01

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.57092E 02	1.09350E-01	1.56629E 02	1.57554E 02	1.56851E 02	1.57332E 02
100.	1.59776E 02	8.91714E-02	1.59335E 02	1.60217E 02	1.59580E 02	1.59973E 02
120.	1.62407E 02	7.41067E-02	1.61980E 02	1.62834E 02	1.62244E 02	1.62570E 02
140.	1.64983E 02	6.46707E-02	1.64563E 02	1.65403E 02	1.64841E 02	1.65125E 02
160.	1.67505E 02	6.06584E-02	1.67088E 02	1.67922E 02	1.67372E 02	1.67639E 02
180.	1.69973E 02	6.07615E-02	1.69556E 02	1.70390E 02	1.69840E 02	1.70107E 02
200.	1.72387E 02	6.30944E-02	1.71968E 02	1.72806E 02	1.72248E 02	1.72526E 02
220.	1.74747E 02	6.60272E-02	1.74326E 02	1.75167E 02	1.74601E 02	1.74892E 02
240.	1.77052E 02	6.85099E-02	1.76629E 02	1.77475E 02	1.76901E 02	1.77203E 02
260.	1.79303E 02	7.00067E-02	1.78879E 02	1.79727E 02	1.79149E 02	1.79457E 02
280.	1.81500E 02	7.03695E-02	1.81075E 02	1.81924E 02	1.81345E 02	1.81655E 02
300.	1.83643E 02	6.97768E-02	1.83219E 02	1.84067E 02	1.83489E 02	1.83796E 02
320.	1.85731E 02	6.87509E-02	1.85308E 02	1.86154E 02	1.85580E 02	1.85883E 02
340.	1.87766E 02	6.82098E-02	1.87343E 02	1.88188E 02	1.87616E 02	1.87916E 02
360.	1.89746E 02	6.94692E-02	1.89322E 02	1.90170E 02	1.89593E 02	1.89899E 02
380.	1.91672E 02	7.40176E-02	1.91245E 02	1.92099E 02	1.91509E 02	1.91835E 02
400.	1.93544E 02	8.30338E-02	1.93109E 02	1.93979E 02	1.93361E 02	1.93727E 02
420.	1.95362E 02	9.70059E-02	1.94913E 02	1.95811E 02	1.95148E 02	1.95575E 02
440.	1.97125E 02	1.15819E-01	1.96655E 02	1.97595E 02	1.96870E 02	1.97380E 02
460.	1.98834E 02	1.39093E-01	1.98335E 02	1.99334E 02	1.98528E 02	1.99140E 02

Table G-3

ELECTRICAL RESISTIVITY OF TITANIUM: POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.569000E 02	1.569757E 02	-7.569885E-02	1
9.750000D 01	1.568000E 02	1.567928E 02	7.202148E-03	2
1.105000D 02	1.568000E 02	1.566803E 02	1.196442E-01	3
1.450000D 02	1.565000E 02	1.564041E 02	9.591675E-02	4
1.740000D 02	1.561000E 02	1.561969E 02	-9.686279E-02	5
1.960000D 02	1.560000E 02	1.560548E 02	-5.482483E-02	6
2.215000D 02	1.559000E 02	1.559066E 02	-6.637573E-03	7
2.565000D 02	1.557000E 02	1.557319E 02	-3.190613E-02	8
2.710000D 02	1.556000E 02	1.556693E 02	-6.925964E-02	9
2.960000D 02	1.556000E 02	1.555746E 02	2.539062E-02	10
3.260000D 02	1.555000E 02	1.554834E 02	1.663208E-02	11
3.665000D 02	1.555000E 02	1.553989E 02	1.010895E-01	12
4.190000D 02	1.554000E 02	1.553556E 02	4.440308E-02	13
4.610000D 02	1.553000E 02	1.553747E 02	-7.473755E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.577822E 02

C_2 = -1.146905E-02

C_3 = 1.355035E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 7.760137E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.56951E 02	4.72538E-02	1.56752E 02	1.57151E 02	1.56847E 02	1.57055E 02
100.	1.56771E 02	3.85340E-02	1.56580E 02	1.56961E 02	1.56686E 02	1.56856E 02
120.	1.56601E 02	3.20241E-02	1.56416E 02	1.56786E 02	1.56531E 02	1.56671E 02
140.	1.56442E 02	2.79464E-02	1.56261E 02	1.56624E 02	1.56381E 02	1.56504E 02
160.	1.56294E 02	2.62126E-02	1.56114E 02	1.56474E 02	1.56236E 02	1.56352E 02
180.	1.56157E 02	2.62571E-02	1.55977E 02	1.56337E 02	1.56099E 02	1.56215E 02
200.	1.56030E 02	2.72653E-02	1.55849E 02	1.56211E 02	1.55970E 02	1.56090E 02
220.	1.55915E 02	2.85326E-02	1.55733E 02	1.56097E 02	1.55852E 02	1.55978E 02
240.	1.55810E 02	2.96055E-02	1.55627E 02	1.55993E 02	1.55745E 02	1.55875E 02
260.	1.55716E 02	3.02523E-02	1.55533E 02	1.55899E 02	1.55650E 02	1.55783E 02
280.	1.55633E 02	3.04091E-02	1.55450E 02	1.55817E 02	1.55566E 02	1.55700E 02
300.	1.55561E 02	3.01530E-02	1.55378E 02	1.55744E 02	1.55495E 02	1.55627E 02
320.	1.55500E 02	2.97096E-02	1.55317E 02	1.55682E 02	1.55434E 02	1.55565E 02
340.	1.55449E 02	2.94758E-02	1.55267E 02	1.55632E 02	1.55384E 02	1.55514E 02
360.	1.55409E 02	3.00200E-02	1.55226E 02	1.55593E 02	1.55343E 02	1.55476E 02
380.	1.55381E 02	3.19856E-02	1.55195E 02	1.55565E 02	1.55310E 02	1.55451E 02
400.	1.55363E 02	3.58818E-02	1.55175E 02	1.55551E 02	1.55284E 02	1.55442E 02
420.	1.55355E 02	4.19196E-02	1.55161E 02	1.55550E 02	1.55263E 02	1.55448E 02
440.	1.55357E 02	5.00492E-02	1.55154E 02	1.55567E 02	1.55249E 02	1.55469E 02
460.	1.55374E 02	6.01071E-02	1.55158E 02	1.55590E 02	1.55241E 02	1.55506E 02

Table G-4

ELECTRICAL RESISTIVITY OF TITANIUM:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^{o}K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	1.8250	1.0234	2.6265	1.3818	2.2681
100	1.5660	0.8178	2.3141	1.2288	1.9031
120	1.3360	0.6111	2.0608	1.0542	1.6177
140	1.1340	0.4139	1.8540	0.8647	1.4032
160	0.9600	0.2366	1.6833	0.6820	1.2379
180	0.8160	0.0887	1.5432	0.5280	1.1039
200	0.6990	0.0289	1.4269	0.4094	0.9885
220	0.6120	-0.1129	1.3369	0.3299	0.8940
240	0.5520	-0.1696	1.2736	0.2786	0.8253
260	0.5200	-0.2047	1.2447	0.2385	0.8014
280	0.5170	-0.2306	1.2646	0.1810	0.8529
300	0.5430	-0.2487	1.3347	0.1178	0.9681

Table G-5

ELECTRICAL RESISTIVITY OF TITANIUM DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	155.3	945.1	1.36(17)	156.1
11.0	1.58(15)	155.2	995.4	1.43(17)	156.0
15.7	2.26(15)	155.3	1049.7	1.51(17)	156.6
16.5	2.38(15)	155.2	1102.3	1.59(17)	156.4
26.1	3.76(15)	158.3	1166.2	1.68(17)	156.2
31.1	4.48(15)	155.8	1204.7	1.73(17)	155.6
34.9	5.03(15)	155.1	1214.3	1.75(17)	157.6
40.9	5.89(15)	155.4	1255.9	1.81(17)	156.5
59.0	8.50(15)	155.4	1307.1	1.88(17)	156.0
63.0	9.07(15)	155.1	1358.3	1.96(17)	156.3
71.8	1.03(16)	155.3	1409.5	2.03(17)	156.9
81.0	1.17(16)	154.9	1460.7	2.10(17)	156.4
82.1	1.18(16)[b]	155.5	1512.5	2.18(17)	156.6
90.1	1.30(16)	155.5	1563.1	2.25(17)	156.5
128.3	1.85(16)	155.3	1613.1	2.32(17)	156.7
164.8	2.37(16)	155.5	1662.7	2.39(17)	157.3
197.6	2.85(16)	155.4	1711.9	2.47(17)	156.5
234.8	3.38(16)	155.4	1756.7	2.53(17)	156.6
235.0	3.38(16)	155.5	1807.9	2.60(17)	159.1
237.8	3.42(16)	155.4	1859.2	2.68(17)	156.6
273.8	3.94(16)	155.5	1899.1	2.73(17)	156.7
309.7	4.46(16)	155.4	1902.4	2.74(17)[b]	156.6
317.2	4.57(16)	155.5	1902.4	2.74(17)[b]	156.6
373.3	5.38(16)	155.5	1902.4	2.74(17)[b]	156.8
431.5	6.21(16)	155.7	1902.4	2.74(17)[b]	156.3
491.5	7.08(16)	155.7	1902.4	2.74(17)[b]	157.0
593.6	8.55(16)	156.2	1902.4	2.74(17)[b]	156.7
610.2	8.79(16)	155.8	1902.4	2.74(17)[b]	156.5
639.2	9.20(16)[b]	155.8	1902.4	2.74(17)[b]	155.4
641.3	9.23(16)	155 8	1905.8	2.74(17)	156.7
666.5	9.60(16)	155.9	1925.4	2.77(17)	156.7
674.1	9.71(16)[b]	155.7	1960.3	2.82(17)	156.8
674.1	9.71(16)[b]	155.7	2000.3	2.88(17)	156.9
674.1	9.71(16)[b]	155.8	2046.1	2.95(17)	155.3
674.1	9.71(16)[b]	155.8	2080.3	3.00(17)	156.9
725.7	1.05(17)	155.5	2120.3	3.05(17)	156.8
777.4	1.12(17)	155.9	2158.6	3.11(17)	156.8
811.7	1.17(17)	156.1	2200.3	3.17(17)	157.3
867.8	1.25(17)	156.2	2237.1	3.22(17)	157.2
902.6	1.30(17)[b]	155.9	2305.0	3.32(17)	157.0
902.6	1.30(17)[b]	155.9	2309.8	3.33(17)	157.0
902.6	1.30(17)[b]	157.0			

[a] Neutron fluence for E > 1 MeV
[b] Reactor at zero power

Table G-6

ELECTRICAL RESISTIVITY OF TITANIUM: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data: Fluence (10^{17} n/cm^2)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
0.0	1.552000E 02	1.553825E 02	-1.824799E-01	0
1.180000D-01	1.555000E 02	1.554362E 02	6.378174E-02	1
9.200000D-01	1.558000E 02	1.558016E 02	-1.586914E-03	2
9.710000D-01	1.557500E 02	1.558248E 02	-7.479858E-02	3
1.299999D 00	1.563000E 02	1.559747E 02	3.253021E-01	4
2.740000D 00	1.565000E 02	1.566307E 02	-1.306610E-01	5
3.330000D 00	1.569000E 02	1.568994E 02	5.493164E-04	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

$C_1 = 1.55382E\ 02$

$C_2 = 4.55547E{-}18$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.821309E{-}01$

d.f. = 5

$t_\alpha = 2.57$

$\alpha = 0.05$

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
0.0	1.55382E 02	1.04843E-01	1.54842E 02	1.55923E 02	1.55113E 02	1.55652E 02
4.000E-01	1.55565E 02	8.84063E-02	1.55044E 02	1.56085E 02	1.55337E 02	1.55792E 02
8.000E-01	1.55747E 02	7.58550E-02	1.55240E 02	1.56254E 02	1.55552E 02	1.55942E 02
1.200E 00	1.55929E 02	6.93321E-02	1.55428E 02	1.56430E 02	1.55751E 02	1.56107E 02
1.600E 00	1.56111E 02	7.05304E-02	1.55609E 02	1.56613E 02	1.55930E 02	1.56293E 02
2.000E 00	1.56294E 02	7.90907E-02	1.55783E 02	1.56804E 02	1.56090E 02	1.56497E 02
2.400E 00	1.56476E 02	9.30250E-02	1.55950E 02	1.57001E 02	1.56237E 02	1.56715E 02
2.800E 00	1.56658E 02	1.10276E-01	1.56111E 02	1.57205E 02	1.56375E 02	1.56941E 02
3.200E 00	1.56840E 02	1.29532E-01	1.56266E 02	1.57415E 02	1.56507E 02	1.57173E 02

Table G-7

ELECTRICAL RESISTIVITY OF INCONEL 718: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.7399990 01	1.081000E 02	1.080619F 02	3.813171E-02	1
9.6000000 01	1.087000E 02	1.087013E 02	-1.281738E-03	2
1.1800000 02	1.094000E 02	1.094546E 02	-5.464172E-02	3
1.4100000 02	1.102000E 02	1.102389E 02	-3.886414E-02	4
1.7100000 02	1.113000E 02	1.112565E 02	4.347229E-02	5
2.0400000 02	1.124000E 02	1.123691E 02	3.089905E-02	6
2.2900000 02	1.132000E 02	1.132072E 02	-7.217407E-03	7
2.5600000 02	1.141000E 02	1.141077E 02	-7.751465E-03	8
2.8250000 02	1.150000E 02	1.149869E 02	1.306152E-02	9
2.9850000 02	1.155000E 02	1.155155F 02	-1.553345E-02	10

Least Squares Fit Coefficients

$\rho = C_1 + C_2 T + C_3 T^2$

C_1 = 1.05377E 02

C_2 = 3.49478E-02

C_3 = -3.28787E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 3.648965E-02

d.f. = 7

t_α = 2.36

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.08151E 02	2.58920E-02	1.08046F 02	1.08257E 02	1.08090E 02	1.08212E 02
90.	1.08495E 02	2.17928E-02	1.08395E 02	1.08596E 02	1.08444E 02	1.08547E 02
100.	1.08838E 02	1.86898E-02	1.08742E 02	1.08935E 02	1.08794E 02	1.08883E 02
110.	1.09181E 02	1.66736E-02	1.09086E 02	1.09276E 02	1.09142E 02	1.09220E 02
120.	1.09523E 02	1.57217E-02	1.09429F 02	1.09617E 02	1.09486E 02	1.09560E 02
130.	1.09864E 02	1.56393E-02	1.09771E 02	1.09958E 02	1.09827E 02	1.09901E 02
140.	1.10205E 02	1.61160E-02	1.10111E 02	1.10299E 02	1.10167E 02	1.10243E 02
150.	1.10545E 02	1.68439F-02	1.10450E 02	1.10640F 02	1.10505E 02	1.10585E 02
160.	1.10884E 02	1.75884E-02	1.10788E 02	1.10980E 02	1.10843E 02	1.10926E 02
170.	1.11223E 02	1.81956E-02	1.11126E 02	1.11319E 02	1.11180E 02	1.11266E 02
180.	1.11561E 02	1.85750E-02	1.11464E 02	1.11657E 02	1.11517E 02	1.11604E 02
190.	1.11898E 02	1.86816E-02	1.11801E 02	1.11995E 02	1.11854E 02	1.11942E 02
200.	1.12235E 02	1.85047E-02	1.12138E 02	1.12331E 02	1.12191E 02	1.12278E 02
210.	1.12571E 02	1.80675E-02	1.12475E 02	1.12667E 02	1.12528E 02	1.12613E 02
220.	1.12906E 02	1.74292E-02	1.12811E 02	1.13001E 02	1.12865E 02	1.12947E 02
230.	1.13241E 02	1.67011E-02	1.13146E 02	1.13335E 02	1.13201E 02	1.13280E 02
240.	1.13575E 02	1.60613E-02	1.13481E 02	1.13669E 02	1.13537E 02	1.13613E 02
250.	1.13908E 02	1.57693E-02	1.13814C 02	1.14002E 02	1.13871E 02	1.13945E 02
260.	1.14241F 02	1.61395E-02	1.14147E 02	1.14335E 02	1.14203E 02	1.14279E 02
270.	1.14573E 02	1.74500E-02	1.14477E 02	1.14668E 02	1.14532E 02	1.14614E 02
280.	1.14904E 02	1.98371E-02	1.14806E 02	1.15002E 02	1.14857E 02	1.14951E 02
290.	1.15235E 02	2.32786E-02	1.15133E 02	1.15337E 02	1.15180E 02	1.15290E 02
300.	1.15565F 02	2.76729E-02	1.15457E 02	1.15673F 02	1.15500E 02	1.15630E 02

Table G-8

ELECTRICAL RESISTIVITY OF INCONEL 718: POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	1.086000E 02	1.085866E 02	1.336670E-02	1
9.700000D 01	1.093000E 02	1.092674E 02	3.260803E-02	2
1.105000D 02	1.097000E 02	1.097323E 02	-3.228760E-02	3
1.460000D 02	1.109000E 02	1.109392E 02	-3.924561E-02	4
1.750000D 02	1.119000E 02	1.119085E 02	-8.468628E-03	5
1.985000D 02	1.127000E 02	1.126828E 02	1.715088E-02	6
2.235000D 02	1.135000E 02	1.134958E 02	4.180908E-03	7
2.610000D 02	1.147000E 02	1.146943E 02	5.676270E-03	8
2.760000D 02	1.152000E 02	1.151667E 02	3.332520E-02	9
2.995000D 02	1.159000E 02	1.158986E 02	1.373291E-03	10
3.300000D 02	1.169000E 02	1.168339E 02	-3.387451E-02	11
3.720000D 02	1.181000E 02	1.180945E 02	5.477905E-03	12
4.235000D 02	1.196000E 02	1.195973E 02	2.731323E-03	13
4.660000D 02	1.208000E 02	1.208017E 02	-1.678467E-03	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.05831E 02

C_2 = 3.62918E-02

C_3 = -8.94065E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.438413E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.08677E 02	1.48032E-02	1.08615E 02	1.08740E 02	1.08645E 02	1.08710E 02
100.	1.09371E 02	1.21110E-02	1.09311E 02	1.09431E 02	1.09344E 02	1.09398E 02
120.	1.10057E 02	1.00955E-02	1.09999E 02	1.10116E 02	1.10035E 02	1.10080E 02
140.	1.10737E 02	8.82319E-03	1.10680E 02	1.10794E 02	1.10717E 02	1.10756E 02
160.	1.11409E 02	8.26846E-03	1.11352E 02	1.11466E 02	1.11391E 02	1.11427E 02
180.	1.12074E 02	8.76373E-03	1.12017E 02	1.12131E 02	1.12056E 02	1.12092E 02
200.	1.12732E 02	8.56399E-03	1.12675E 02	1.12789E 02	1.12713E 02	1.12751E 02
220.	1.13383E 02	8.95357E-03	1.13326E 02	1.13440E 02	1.13363E 02	1.13402E 02
240.	1.14026E 02	9.29073E-03	1.13969E 02	1.14084E 02	1.14006E 02	1.14047E 02
260.	1.14663E 02	9.50075E-03	1.14605E 02	1.14720E 02	1.14642E 02	1.14684E 02
280.	1.15292E 02	9.55971E-03	1.15234E 02	1.15350E 02	1.15271E 02	1.15313E 02
300.	1.15914E 02	9.48607E-03	1.15857E 02	1.15972E 02	1.15893E 02	1.15935E 02
320.	1.16529E 02	9.34150E-03	1.16472E 02	1.16587E 02	1.16509E 02	1.16550E 02
340.	1.17137E 02	9.23840E-03	1.17080E 02	1.17194E 02	1.17117E 02	1.17157E 02
360.	1.17738E 02	9.34197E-03	1.17680E 02	1.17795E 02	1.17717E 02	1.17758E 02
380.	1.18331E 02	9.84825E-03	1.18273E 02	1.18389E 02	1.18309E 02	1.18353E 02
400.	1.18917E 02	1.09251E-02	1.18859E 02	1.18976E 02	1.18893E 02	1.18941E 02
420.	1.19497E 02	1.26554E-02	1.19435E 02	1.19557E 02	1.19469E 02	1.19524E 02
440.	1.20069E 02	1.50360E-02	1.20005E 02	1.20132E 02	1.20036E 02	1.20102E 02
460.	1.20634E 02	1.80202E-02	1.20567E 02	1.20700E 02	1.20594E 02	1.20673E 02

Table G-9

ELECTRICAL RESISTIVITY OF INCONEL 718:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^oK)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.52600	0.42031	0.63168	0.46776	0.58423
100	0.53300	0.43421	0.63178	0.48850	0.57749
120	0.53400	0.43825	0.62974	0.49673	0.57126
140	0.53200	0.43688	0.62711	0.49639	0.56760
160	0.52500	0.42945	0.62054	0.48824	0.56175
180	0.51300	0.41691	0.60908	0.47486	0.55113
200	0.49700	0.40077	0.59322	0.45853	0.53546
220	0.47700	0.38113	0.57286	0.43942	0.51457
240	0.45100	0.35562	0.54637	0.41469	0.48730
260	0.42200	0.32649	0.51750	0.38536	0.45863
280	0.38800	0.29040	0.48559	0.34620	0.42979
300	0.34900	0.24602	0.45197	0.29584	0.40215

Table G-10

ELECTRICAL RESISTIVITY OF INCONEL 718 DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	108.1	945.1	1.36(17)	108.3
11.0	1.58(15)	108.1	995.4	1.43(17)	108.4
15.7	2.26(15)	108.1	1049.7	1.51(17)	108.3
16.5	2.38(15)	108.1	1102.3	1.59(17)	108.4
26.1	3.76(15)	108.1	1166.2	1.68(17)	108.4
31.1	4.48(15)	108.1	1204.7	1.73(17)	108.4
34.9	5.03(15)	108.1	1214.3	1.75(17)	108.4
40.9	5.89(15)	108.1	1255.9	1.81(17)	108.4
59.0	8.50(15)	108.2	1307.1	1.88(17)	108.4
63.0	9.07(15)	108.1	1358.3	1.96(17)	108.5
71.8	1.03(16)	108.1	1409.5	2.03(17)	108.5
81.0	1.17(16)	108.1	1460.7	2.10(17)	108.5
82.1	1.18(16)[b]	108.1	1512.5	2.18(17)	108.5
90.1	1.30(16)	108.1	1563.1	2.25(17)	108.5
128.3	1.85(16)	108.1	1613.1	2.32(17)	108.5
164.8	2.37(16)	108.1	1662.7	2.39(17)	108.5
197.6	2.85(16)	108.2	1711.9	2.47(17)	108.5
234.8	3.38(16)	108.2	1756.7	2.53(17)	108.5
235.0	3.38(16)	108.2	1807.9	2.60(17)	108.5
237.8	3.42(16)	108.1	1859.2	2.68(17)	108.6
273.8	3.94(16)	108.2	1899.1	2.73(17)	108.6
309.7	4.46(16)	108.2	1902.4	2.74(17)[b]	108.6
317.2	4.57(16)	108.2	1902.4	2.74(17)[b]	108.5
373.3	5.38(16)	108.2	1902.4	2.74(17)[b]	108.5
431.5	6.21(16)	108.2	1902.4	2.74(17)[b]	108.5
491.5	7.08(16)	108.2	1902.4	2.74(17)[b]	108.6
593.6	8.55(16)	108.3	1902.4	2.74(17)[b]	108.5
610.2	8.79(16)	108.3	1902.4	2.74(17)[b]	108.6
639.2	9.20(16)[b]	108.2	1902.4	2.74(17)[b]	108.5
641.3	9.23(16)	108.3	1905.8	2.74(17)	108.5
666.5	9.60(16)	108.3	1925.4	2.77(17)	108.6
674.1	9.71(16)[b]	108.2	1960.3	2.82(17)	108.6
674.1	9.71(16)[b]	108.2	2000.3	2.88(17)	108.6
674.1	9.71(16)[b]	108.2	2046.1	2.95(17)	108.6
674.1	9.71(16)[b]	108.2	2080.3	3.00(17)	108.6
725.7	1.05(17)	108.3	2120.3	3.05(17)	108.6
777.4	1.12(17)	108.3	2158.6	3.11(17)	108.6
811.7	1.17(17)	108.3	2200.3	3.17(17)	108.6
867.8	1.25(17)	108.3	2237.1	3.22(17)	108.6
902.6	1.30(17)[b]	108.3	2305.0	3.32(17)	108.6
902.6	1.30(17)[b]	108.3	2309.8	3.33(17)	108.6
902.6	1.30(17)[b]	108.3			

[a] Neutron fluence for E > 1 MeV
[b] Reactor at zero power

Table G-11

ELECTRICAL RESISTIVITY OF INCONEL 718: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data: Fluence (10^{17} n/cm^2)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
0.0	1.081000E 02	1.080770E 02	2.304077E-02	0
1.180000D-01	1.081000E 02	1.080958E 02	4.165649E-03	1
9.200000D-01	1.082000E 02	1.082242E 02	-2.420044E-02	2
9.710000D-01	1.082000E 02	1.082324E 02	-3.236389E-02	3
1.299999D 00	1.083000E 02	1.082850E 02	1.496887E-02	4
2.740000D 00	1.085400E 02	1.085155E 02	2.447510E-02	5
3.330000D 00	1.086000E 02	1.086100E 02	-9.963989E-03	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

$C_1 = 1.08077E\ 02$

$C_2 = 1.60062E-18$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 2.491461E-02$

d.f. = 5

$t_\alpha = 2.57$

$\alpha = 0.05$

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	1.08077E 02	1.43420E-02	1.08003E 02	1.08151E 02	1.08040E 02	1.08114E 02
4.000E-01	1.08141E 02	1.20936E-02	1.08070E 02	1.08212E 02	1.08110E 02	1.08172E 02
8.000E-01	1.08205E 02	1.03766E-02	1.08136E 02	1.08274E 02	1.08178E 02	1.08232E 02
1.200E 00	1.08269E 02	9.48429E-03	1.08200E 02	1.08338E 02	1.08245E 02	1.08293E 02
1.600E 00	1.08333E 02	9.64821E-03	1.08264E 02	1.08402E 02	1.08308E 02	1.08358E 02
2.000E 00	1.08397E 02	1.08205E-02	1.08327E 02	1.08467E 02	1.08369E 02	1.08425E 02
2.400E 00	1.08461E 02	1.27254E-02	1.08389E 02	1.08533E 02	1.08428E 02	1.08494E 02
2.800E 00	1.08525E 02	1.50879E-02	1.08450E 02	1.08600E 02	1.08486E 02	1.08564E 02
3.200E 00	1.08589E 02	1.77261E-02	1.08511E 02	1.08668E 02	1.08544E 02	1.08635E 02

Table G-12

ELECTRICAL RESISTIVITY OF HASTELLOY X: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^oK)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.088000E 02	1.088192E 02	-1.922607E-02	1
9.600000D 01	1.094000E 02	1.094005E 02	-4.577637E-04	2
1.185000D 02	1.101000E 02	1.100871E 02	1.286316E-02	3
1.415000D 02	1.108000E 02	1.107705E 02	2.951050E-02	4
1.705000D 02	1.116000E 02	1.116053E 02	-5.279541E-03	5
2.035000D 02	1.125000E 02	1.125188E 02	-1.884460E-02	6
2.285000D 02	1.132000E 02	1.131852E 02	1.481628E-02	7
2.555000D 02	1.139000E 02	1.138799E 02	2.012634E-02	8
2.815000D 02	1.144000E 02	1.145243E 02	-1.243439E-01	9
2.975000D 02	1.150000E 02	1.149090E 02	9.100342E-02	10

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

$C_1 = 1.06268E\ 02$

$C_2 = 3.43314E\text{-}02$

$C_3 = -1.77732E\text{-}05$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 6.112842E\text{-}02$

d.f. = 7

$t_\alpha = 2.36$

$\alpha = 0.05$

Temperature (^oK)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.08901E 02	4.35007E-02	1.08724E 02	1.09078E 02	1.08799E 02	1.09004E 02
90.	1.09214E 02	3.65916E-02	1.09046E 02	1.09382E 02	1.09128E 02	1.09301E 02
100.	1.09524E 02	3.13605E-02	1.09362E 02	1.09686E 02	1.09450E 02	1.09598E 02
110.	1.09830E 02	2.79604E-02	1.09671E 02	1.09988E 02	1.09764E 02	1.09896E 02
120.	1.10132E 02	2.63528E-02	1.09975E 02	1.10289E 02	1.10070E 02	1.10194E 02
130.	1.10431E 02	2.62089E-02	1.10274E 02	1.10588E 02	1.10369E 02	1.10493E 02
140.	1.10726E 02	2.70040E-02	1.10569E 02	1.10884E 02	1.10663E 02	1.10790E 02
150.	1.11018E 02	2.82183E-02	1.10859E 02	1.11177E 02	1.10952E 02	1.11085E 02
160.	1.11306E 02	2.94567E-02	1.11146E 02	1.11467E 02	1.11237E 02	1.11376E 02
170.	1.11591E 02	3.04610E-02	1.11430E 02	1.11752E 02	1.11519E 02	1.11663E 02
180.	1.11872E 02	3.10789E-02	1.11710E 02	1.12034E 02	1.11799E 02	1.11946E 02
190.	1.12150E 02	3.12356E-02	1.11988E 02	1.12312E 02	1.12076E 02	1.12224E 02
200.	1.12424E 02	3.09161E-02	1.12262E 02	1.12585E 02	1.12351E 02	1.12497E 02
210.	1.12694E 02	3.01625E-02	1.12533E 02	1.12855E 02	1.12623E 02	1.12765E 02
220.	1.12961E 02	2.90777E-02	1.12801E 02	1.13121E 02	1.12892E 02	1.13030E 02
230.	1.13224E 02	2.78578E-02	1.13066E 02	1.13383E 02	1.13159E 02	1.13290E 02
240.	1.13484E 02	2.68148E-02	1.13327E 02	1.13642E 02	1.13421E 02	1.13548E 02
250.	1.13740E 02	2.63958E-02	1.13583E 02	1.13898E 02	1.13678E 02	1.13803E 02
260.	1.13993E 02	2.71348E-02	1.13835E 02	1.14151E 02	1.13929E 02	1.14057E 02
270.	1.14242E 02	2.94917E-02	1.14082E 02	1.14402E 02	1.14173E 02	1.14312E 02
280.	1.14488E 02	3.36688E-02	1.14323E 02	1.14652E 02	1.14408E 02	1.14567E 02
290.	1.14730E 02	3.96137E-02	1.14558E 02	1.14902E 02	1.14636E 02	1.14823E 02
300.	1.14968E 02	4.71463E-02	1.14786E 02	1.15150E 02	1.14857E 02	1.15080E 02

Table G-13

ELECTRICAL RESISTIVITY OF HASTELLOY X: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^{o}K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.089000E 02	1.088600E 02	4.000854E-02	1
9.700000D 01	1.094000E 02	1.094317E 02	-3.172302E-02	2
1.105000D 02	1.098000E 02	1.098216E 02	-2.157593E-02	3
1.455000D 02	1.108000E 02	1.108173E 02	-1.728821E-02	4
1.750000D 02	1.116000E 02	1.116397E 02	-3.974915E-02	5
1.985000D 02	1.123000E 02	1.122839E 02	1.608276E-02	6
2.230000D 02	1.130000E 02	1.129451E 02	5.490112E-02	7
2.615000D 02	1.140000E 02	1.139627E 02	3.729248E-02	8
2.760000D 02	1.144000E 02	1.143392E 02	6.082153E-02	9
2.995000D 02	1.149000E 02	1.149414E 02	-4.142761E-02	10
3.305000D 02	1.157000E 02	1.157210E 02	-2.096558E-02	11
3.720000D 02	1.167000E 02	1.167380E 02	-3.796387E-02	12
4.235000D 02	1.179000E 02	1.179577E 02	-5.770874E-02	13
4.665000D 02	1.190000E 02	1.189403E 02	5.973816E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.065359E 02

C_2 = 3.071012E-02

C_3 = -8.831548E-06

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 4.652487E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (^{o}K)	ρ (μohm-cm)	$s_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.08936E 02	2.82191E-02	1.08814E 02	1.09056E 02	1.08874E 02	1.08998E 02
100.	1.09519E 02	2.30899E-02	1.09404E 02	1.09633E 02	1.09468E 02	1.09569E 02
120.	1.10094E 02	1.92506E-02	1.09983E 02	1.10205E 02	1.10052E 02	1.10136E 02
140.	1.10662E 02	1.68281E-02	1.10553E 02	1.10771E 02	1.10625E 02	1.10699E 02
160.	1.11223E 02	1.57731E-02	1.11115E 02	1.11332E 02	1.11189E 02	1.11258E 02
180.	1.11778E 02	1.57663E-02	1.11670E 02	1.11886E 02	1.11743E 02	1.11812E 02
200.	1.12325E 02	1.63406E-02	1.12215E 02	1.12433E 02	1.12289E 02	1.12361E 02
220.	1.12865E 02	1.70854E-02	1.12756E 02	1.12974E 02	1.12827E 02	1.12902E 02
240.	1.13398E 02	1.77304E-02	1.13289E 02	1.13507E 02	1.13359E 02	1.13437E 02
260.	1.13924E 02	1.81332E-02	1.13814E 02	1.14033E 02	1.13884E 02	1.13963E 02
280.	1.14442E 02	1.82478E-02	1.14332E 02	1.14552E 02	1.14402E 02	1.14483E 02
300.	1.14954E 02	1.81089E-02	1.14844E 02	1.15064E 02	1.14914E 02	1.14994E 02
320.	1.15459E 02	1.78333E-02	1.15349E 02	1.15568E 02	1.15420E 02	1.15498E 02
340.	1.15956E 02	1.76339E-02	1.15847E 02	1.16066E 02	1.15918E 02	1.15995E 02
360.	1.16447E 02	1.78242E-02	1.16337E 02	1.16557E 02	1.16408E 02	1.16486E 02
380.	1.16930E 02	1.87771E-02	1.16820E 02	1.17041E 02	1.16889E 02	1.16972E 02
400.	1.17407E 02	2.08140E-02	1.17295E 02	1.17519E 02	1.17361E 02	1.17453E 02
420.	1.17876E 02	2.40949E-02	1.17761E 02	1.17992E 02	1.17823E 02	1.17929E 02
440.	1.18339E 02	2.86157E-02	1.18218E 02	1.18459E 02	1.18276E 02	1.18402E 02
460.	1.18794E 02	3.42881E-02	1.18667E 02	1.18921E 02	1.18718E 02	1.18869E 02

Table G-14

ELECTRICAL RESISTIVITY OF HASTELLOY X:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^oK)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.03500	-0.15266	0.22266	-0.06850	0.13850
100	-0.00500	-0.18034	0.17034	-0.08401	0.07401
120	-0.03800	-0.20793	0.13193	-0.10414	0.02814
140	-0.06400	-0.23281	0.10481	-0.12719	-0.00080
160	-0.08300	-0.25258	0.08658	-0.14821	-0.01778
180	-0.09400	-0.26452	0.07652	-0.16163	-0.02636
200	-0.09900	-0.26973	0.07173	-0.16715	-0.03084
220	-0.09600	-0.26608	0.07408	-0.16251	-0.02948
240	-0.08600	-0.25523	0.08323	-0.15032	-0.02167
260	-0.06900	-0.23864	0.10064	-0.13438	-0.00361
280	-0.04600	-0.21951	0.12751	-0.12084	0.02884
300	-0.01400	-0.19743	0.16943	-0.10962	0.08162

Table G-15

ELECTRICAL RESISTIVITY OF HASTELLOY X DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	109.4	945.1	1.36(17)	109.0
11.0	1.58(15)	108.9	995.4	1.43(17)	109.0
15.7	2.26(15)	108.9	1049.7	1.51(17)	109.0
16.5	2.38(15)	108.9	1102.3	1.59(17)	109.0
26.1	3.76(15)	108.9	1166.2	1.68(17)	109.0
31.1	4.48(15)	108.9	1204.7	1.73(17)	109.0
34.9	5.03(15)	108.9	1214.3	1.75(17)	109.0
40.9	5.89(15)	108.9	1255.9	1.81(17)	109.1
59.0	8.50(15)	108.9	1307.1	1.88(17)	109.0
63.0	9.07(15)	108.9	1358.3	1.96(17)	109.0
71.8	1.03(16)	109.0	1409.5	2.03(17)	109.0
81.0	1.17(16)	108.9	1460.7	2.10(17)	109.0
82.1	1.18(16)[b]	108.9	1512.5	2.18(17)	109.0
90.1	1.30(16)	108.9	1563.1	2.25(17)	109.0
128.3	1.85(16)	108.9	1613.1	2.32(17)	108.9
164.8	2.37(16)	108.8	1662.7	2.39(17)	108.9
197.6	2.85(16)	108.9	1711.9	2.47(17)	109.0
234.8	3.38(16)	109.0	1756.7	2.53(17)	109.0
235.0	3.38(16)	109.0	1807.9	2.60(17)	109.0
237.8	3.42(16)	108.9	1859.2	2 68(17)	109.1
273.8	3.94(16)	108.9	1899.1	2.73(17)	109.0
309.7	4.46(16)	108.9	1902.4	2.74(17)[b]	108.9
317.2	4.57(16)	109.0	1902.4	2.74(17)[b]	108.3
373.3	5.38(16)	109.0	1902.4	2.74(17)[b]	108.8
431.5	6.21(16)	109.0	1902.4	2.74(17)[b]	108.8
491.5	7.08(16)	109.0	1902.4	2.74(17)[b]	108.8
593.6	8.55(16)	109.0	1902.4	2.74(17)[b]	108.9
610.2	8.79(16)	109.1	1902.4	2.74(17)[b]	108.9
639.2	9.20(16)[b]	108.9	1902.4	2.74(17)[b]	108.7
641.3	9.23(16)	108.9	1905.8	2.74(17)	108.9
666.5	9.60(16)	108.9	1925.4	2.77(17)	108.9
674.1	9.71(16)[b]	108.9	1960.3	2.82(17)	108.9
674.1	9.71(16)[b]	108.9	2000.3	2.88(17)	108.9
674.1	9.71(16)[b]	108.9	2046.1	2.95(17)	108.9
674.1	9.71(16)[b]	108.9	2080.3	3.00(17)	108.9
725.7	1.05(17)	109.0	2120.3	3.05(17)	108.9
777.4	1.12(17)	109.0	2158.6	3.11(17)	108.9
811.7	1.17(17)	108.3	2200.3	3.17(17)	108.8
867.8	1.25(17)	109.1	2237.1	3.22(17)	108.9
902.6	1.30(17)[b]	108.9	2305.0	3.32(17)	108.9
902.6	1.30(17)[b]	108.9	2309.8	3.33(17)	108.9
902.6	1.30(17)[b]	108.9			

[a] Neutron fluence for E > 1 MeV
[b] Reactor at zero power

Table G-16

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^oK)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	2.360000E 03	2.127902E 03	2.320977E 02	1
7.739999D 01	2.358000E 03	2.127902E 03	2.300977E 02	1
7.739999D 01	1.794000E 03	2.127902E 03	-3.339023E 02	2
7.739999D 01	1.785000E 03	2.127902E 03	-3.429023E 02	2
7.739999D 01	2.270000E 03	2.127902E 03	1.420977E 02	3
7.739999D 01	2.270000E 03	2.127902E 03	1.420977E 02	3
7.739999D 01	2.094000E 03	2.127902E 03	-3.390234E 01	4
7.739999D 01	2.098000E 03	2.127902E 03	-2.990234E 01	4
9.650000D 01	2.149000E 03	2.175038E 03	-2.603760E 01	5
9.650000D 01	2.228000E 03	2.175038E 03	5.296240E 01	5
9.500000D 01	2.110000E 03	2.174344E 03	-6.434351E 01	6
9.500000D 01	2.109000E 03	2.174344E 03	-6.534351E 01	6
9.650000D 01	2.224000E 03	2.175038E 03	4.896240E 01	7
9.650000D 01	2.227000E 03	2.175038E 03	5.196240E 01	7
1.190000D 02	2.129400E 03	2.128659E 03	7.404785E-01	8
1.180000D 02	2.124000E 03	2.128659E 03	-4.659424E 00	8

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.08605E 03

C_2 = 2.22777E 01

C_3 = -1.13915E-01

Statistical Terms

$s_e = \sqrt{\Sigma(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.743838E 02

d.f. = 13

t_α = 2.16

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.13921E 03	5.28362E 01	1.74563E 03	2.53278E 03	2.02508E 03	2.25333E 03
90.	2.16933E 03	6.38206E 01	1.76722E 03	2.56943E 03	2.03047E 03	2.30618E 03
100.	2.17466E 03	7.21839E 01	1.76700E 03	2.58233E 03	2.01875E 03	2.33058E 03
110.	2.15822E 03	7.61430E 01	1.74546E 03	2.57098E 03	1.98943E 03	2.32701E 03
120.	2.11899E 03	1.41954E 02	1.63330E 03	2.60468E 03	1.81237E 03	2.42561E 03

Table G-17

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^{o}K)	Resistivity (μohm-cm)	Resistivity (ohm-cm)	Residuals (input-calc)	
7.739999D 01	3.409000E 03	3.552599E 03	-1.435994E 02	1
1.090000D 02	3.427000E 03	3.427362E 03	-3.620605E-01	2
1.450000D 02	3.396000E 03	3.274750E 03	1.212500E 02	3
1.735000D 02	3.283000E 03	3.146427E 03	1.365735E 02	4
1.955000D 02	3.127000E 03	3.042834E 03	8.416626E 01	5
2.210000D 02	2.922000E 03	2.917814E 03	4.185547E 00	6
2.565000D 02	2.663000E 03	2.734926E 03	-7.192603E 01	7
2.705000D 02	2.585000E 03	2.659971E 03	-7.497119E 01	8
2.945000D 02	2.453000E 03	2.527754E 03	-7.475415E 01	9
3.255000D 02	2.321000E 03	2.350012E 03	-2.901172E 01	10
3.660000D 02	2.097000E 03	2.105977E 03	-8.976562E 00	11
4.170000D 02	1.790000E 03	1.779619E 03	1.038062E 01	12
4.600000D 02	1.535000E 03	1.487952E 03	4.704834E 01	13

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 3.82490E 03

C_2 = -3.20212E 00

C_3 = -4.08307E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 8.983414E 01

d.f. = 10

t_α = 2.23

α = 0.05

Temperature (^{o}K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	3.54260E 03	6.30923E 01	3.29780E 03	3.78740E 03	3.40191E 03	3.68330E 03
100.	3.46386E 03	5.15834E 01	3.23285E 03	3.69487E 03	3.34883E 03	3.57889E 03
120.	3.38185E 03	4.25345E 01	3.16020E 03	3.60350E 03	3.28700E 03	3.47671E 03
140.	3.29658E 03	3.62209E 01	3.08058E 03	3.51258E 03	3.21581E 03	3.37735E 03
160.	3.20804E 03	3.27094E 01	2.99484E 03	3.42123E 03	3.13510E 03	3.28098E 03
180.	3.11623E 03	3.15966E 01	2.90387E 03	3.32859E 03	3.04577E 03	3.18669E 03
200.	3.02116E 03	3.20479E 01	2.80846E 03	3.23385E 03	2.94969E 03	3.09262E 03
220.	2.92282E 03	3.31715E 01	2.70927E 03	3.13637E 03	2.84884E 03	2.99679E 03
240.	2.82121E 03	3.43078E 01	2.60677E 03	3.03565E 03	2.74470E 03	2.89772E 03
260.	2.71634E 03	3.50769E 01	2.50128E 03	2.93140E 03	2.63812E 03	2.79456E 03
280.	2.60820E 03	3.53310E 01	2.39293E 03	2.82346E 03	2.52941E 03	2.68699E 03
300.	2.49679E 03	3.51142E 01	2.28170E 03	2.71188E 03	2.41849E 03	2.57510E 03
320.	2.38212E 03	3.46616E 01	2.16740E 03	2.59684E 03	2.30482E 03	2.45942E 03
340.	2.26419E 03	3.44217E 01	2.04965E 03	2.47871E 03	2.18742E 03	2.34094E 03
360.	2.14298E 03	3.50595E 01	1.92793E 03	2.35802E 03	2.06479E 03	2.22116E 03
380.	2.01850E 03	3.73457E 01	1.80155E 03	2.23546E 03	1.93522E 03	2.10178E 03
400.	1.89077E 03	4.19087E 01	1.66971E 03	2.11182E 03	1.79731E 03	1.98422E 03
420.	1.75976E 03	4.90248E 01	1.53154E 03	1.98798E 03	1.65044E 03	1.86909E 03
440.	1.62549E 03	5.86504E 01	1.38624E 03	1.86473E 03	1.49470E 03	1.75628E 03
460.	1.48795E 03	7.05976E 01	1.23316E 03	1.74274E 03	1.33052E 03	1.64538E 03

Table G-18

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: POSTIRRADIATION-ANNEAL DATA TAKEN AT LN2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	3.409000E 03	3.502000E 03	-9.300049E 01	1
1.090000D 02	3.493000E 03	3.468241E 03	2.475903E 01	2
1.450000D 02	3.512000E 03	3.422056E 03	8.994409E 01	3
1.735000D 02	3.472000E 03	3.379658E 03	9.234204E 01	4
1.955000D 02	3.386000E 03	3.343404E 03	4.259644E 01	5
2.210000D 02	3.268000E 03	3.297537E 03	-2.953662E 01	6
2.565000D 02	3.150000E 03	3.226810E 03	-7.680957E 01	7
2.705000D 02	3.116000E 03	3.196718E 03	-8.071753E 01	8
2.945000D 02	3.079000E 03	3.142236E 03	-6.323633E 01	9
3.255000D 02	3.061000E 03	3.066453E 03	-5.453369E 00	10
3.660000D 02	3.010000E 03	2.958255E 03	5.174512E 01	11
4.175000D 02	2.927000E 03	2.805631E 03	1.213691E 02	12
4.600000D 02	2.593000E 03	2.666998E 03	-7.399829E 01	13

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 3.55791E 03

C_2 = -4.76705E-01

C_3 = -3.17405E-03

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 8.239735E 01

d.f. = 10

t_α = 2.23

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	3.49946E 03	5.78686E 01	3.27493E 03	3.72400E 03	3.37042E 03	3.62851E 03
100.	3.47850E 03	4.73137E 01	3.26662E 03	3.69039E 03	3.37299E 03	3.58401E 03
120.	3.45500E 03	3.90140E 01	3.25170E 03	3.65830E 03	3.36800E 03	3.54200E 03
140.	3.42896E 03	3.32218E 01	3.23084E 03	3.62708E 03	3.35488E 03	3.50305E 03
160.	3.40038E 03	2.99996E 01	3.20484E 03	3.59593E 03	3.33348E 03	3.46728E 03
180.	3.36927E 03	2.99780E 01	3.17449E 03	3.56404E 03	3.30465E 03	3.43389E 03
200.	3.33561E 03	2.93921E 01	3.14052E 03	3.53070E 03	3.27007E 03	3.40115E 03
220.	3.29941E 03	3.04242E 01	3.10354E 03	3.49528E 03	3.23157E 03	3.36726E 03
240.	3.26069E 03	3.14689E 01	3.06399E 03	3.45737E 03	3.19050E 03	3.33085E 03
260.	3.21940E 03	3.21775E 01	3.02214E 03	3.41666E 03	3.14765E 03	3.29116E 03
280.	3.17559E 03	3.24135E 01	2.97814E 03	3.37304E 03	3.10331E 03	3.24787E 03
300.	3.12924E 03	3.22171E 01	2.93194E 03	3.32653E 03	3.05739E 03	3.20108E 03
320.	3.08034E 03	3.18024E 01	2.88339E 03	3.27730E 03	3.00942E 03	3.15126E 03
340.	3.02891E 03	3.15793E 01	2.83213E 03	3.22569E 03	2.95849E 03	3.09933E 03
360.	2.97494E 03	3.21558E 01	2.77770E 03	3.17218E 03	2.90323E 03	3.04665E 03
380.	2.91843E 03	3.42387E 01	2.71945E 03	3.11741E 03	2.84208E 03	2.99478E 03
400.	2.85938E 03	3.84051E 01	2.65665E 03	3.06211E 03	2.77374E 03	2.94503E 03
420.	2.79779E 03	4.49111E 01	2.58853E 03	3.00706E 03	2.69764E 03	2.89795E 03
440.	2.73367E 03	5.37184E 01	2.51432E 03	2.95301E 03	2.61387E 03	2.85346E 03
460.	2.66700E 03	6.46558E 01	2.43344E 03	2.90056E 03	2.52282E 03	2.81118E 03

Table G-19

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^{o}K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	1403.3	924.8	1881.9	1175.7	1631.0
90	1335.3	861.1	1809.4	1117.1	1553.4
100	1289.2	818.4	1759.9	1078.5	1499.8
110	1265.0	797.1	1732.9	1060.6	1469.4
120	1262.8	757.1	1768.5	982.5	1543.1

Table G-20

ELECTRICAL RESISTIVITY OF GRAPHITE DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	1292.0	945.1	1.36(17)	3140.6
11.0	1.58(15)	1326.0	995.4	1.43(17)	3158.0
15.7	2.26(15)	1841.0	1049.7	1.51(17)	3173.0
16.5	2.38(15)	2188.0	1102.3	1.59(17)	2974.0
26.1	3.76(15)	2184.0	1166.2	1.68(17)	2987.0
31.1	4.48(15)	2193.0	1204.7	1.73(17)	3089.0
34.9	5.03(15)	2428.0	1214.3	1.75(17)	3201.0
40.9	5.89(15)	2457.0	1255.9	1.81(17)	3145.0
59.0	8.50(15)	2451.6	1307.1	1.88(17)	3154.0
63.0	9.07(15)	1314.0	1358.3	1.96(17)	3179.0
71.8	1.03(16)	1662.9	1409.5	2.03(17)	3205.0
81.0	1.17(16)		1460.7	2.10(17)	3238.0
82.1	1.18(16)[b]	1816.0	1512.5	2.18(17)	3246.0
90.1	1.30(16)	1797.0	1563.1	2.25(17)	3284.0
128.3	1.85(16)	1805.0	1613.1	2.32(17)	3245.0
164.8	2.37(16)	1846.0	1662.7	2.39(17)	3284.0
197.6	2.85(16)	1839.0	1711.9	2.47(17)	3307.0
234.8	3.38(16)	1769.0	1756.7	2.53(17)	3313.0
235.0	3.38(16)	1750.0	1807.9	2.60(17)	3332.0
237.8	3.42(16)	1710.0	1859.2	2.68(17)	3338.0
273.8	3.94(16)	1688.0	1899.1	2.73(17)	3343.0
309.7	4.46(16)	2796.0	1902.4	2.74(17)[b]	3343.0
317.2	4.57(16)	2803.0	1902.4	2.74(17)[b]	3323.0
373.3	5.38(16)	2847.0	1902.4	2.74(17)[b]	3316.0
431.5	6.21(16)	2890.0	1902.4	2.74(17)[b]	3306.0
491.5	7.08(16)	2922.0	1902.4	2.74(17)[b]	3308.0
593.6	8.55(16)	2989.0	1902.4	2.74(17)[b]	3322.0
610.2	8.79(16)	2999.0	1902.4	2.74(17)[b]	3355.0
639.2	9.20(16)[b]	3011.9	1902.4	2.74(17)[b]	3345.0
641.3	9.23(16)	3013.9	1905.8	2.74(17)	3361.0
666.5	9.60(16)	3023.3	1925.4	2.77(17)	3362.0
674.1	9.71(16)[b]	3022.3	1960.3	2.82(17)	2906.1
674.1	9.71(16)[b]	3034.0	2000.3	2.88(17)	2909.0
674.1	9.71(16)[b]	3032.9	2046.1	2.95(17)	3233.8
674.1	9.71(16)[b]	3034.5	2080.3	3.00(17)	2732.0
725.7	1.05(17)	3056.5	2120.3	3.05(17)	3340.7
777.4	1.12(17)	3067.0	2158.6	3.11(17)	3392.0
811.7	1.17(17)	3089.6	2200.3	3.17(17)	3395.0
867.8	1.25(17)	3106.0	2237.1	3.22(17)	3400.0
902.6	1.30(17)[b]	3125.9	2305.0	3.32(17)	3407.0
902.6	1.30(17)[b]	3127.2	2309.8	3.33(17)	3410.0
902.6	1.30(17)[b]	3127.5			

[a] Neutron fluence for E 1 MeV

[b] Reactor at zero power

Table G-21

ELECTRICAL RESISTIVITY OF PO-3 GRAPHITE: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	2.364000E 03	2.365432E 03	-1.432129E 00	0
9.200000D-01	3.011900E 03	3.005187E 03	6.712402E 00	2
9.710000D-01	3.030900E 03	3.026673E 03	4.227051E 00	3
1.299999D 00	3.126900E 03	3.138533E 03	-1.163330E 01	4
2.740000D 00	3.331000E 03	3.327198E 03	3.801514E 00	5
3.330000D 00	3.410000E 03	3.411666E 03	-1.666260F 00	6

Least Squares Fit Coefficients

$$\rho = C_1 + C_2\phi + C_3\phi^2 + C_4\phi^3$$

C_1 = 2.36543E 03

C_2 = 1.00210E-14

C_3 = -3.81787E-32

C_4 = 5.26146E-50

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.042921E 01

d.f. = 2

t_α = 4.30

α = 0.05

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	2.36543E 03	1.03798E 01	2.30216E 03	2.42870F 03	2.32080E 03	2.41006F 03
4.000E-01	2.70855E 03	7.05458E 00	2.65441E 03	2.76269F 03	2.67822E 03	2.73889E 03
8.000E-01	2.94970E 03	6.48137E 00	2.89690E 03	3.00250E 03	2.92183E 03	2.97757E 03
1.200E 00	3.10909E 03	6.15329E 00	3.05702E 03	3.16116E 03	3.08264E 03	3.13555E 03
1.600E 00	3.20692E 03	7.63792E 00	3.15134E 03	3.26251F 03	3.17408E 03	3.23977E 03
2.000E 00	3.26339E 03	1.01567E 01	3.20080E 03	3.32599E 03	3.21972E 03	3.30707E 03
2.400E 00	3.29872E 03	1.13447E 01	3.23245E 03	3.36498E 03	3.24993E 03	3.34750E 03
2.800E 00	3.33309E 03	9.63023E 00	3.27205E 03	3.39413E 03	3.29168E 03	3.37450E 03
3.200E 00	3.38672E 03	8.12818F 00	3.32986E 03	3.44358F 03	3.35177E 03	3.42167E 03

Table G-22

ELECTRICAL RESISTIVITY OF INCONEL*: PREIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D-01	1.207000E 02	1.207184E 02	-1.843262E-02	1
9.650000D 01	1.210000E 02	1.210069E 02	-6.912231E-03	2
1.190000D 02	1.214000E 02	1.213482E 02	5.181885E-02	3
1.415000D 02	1.217000E 02	1.216909E 02	9.063721E-03	4
1.705000D 02	1.221000E 02	1.221350E 02	-3.497314E-02	5
2.035000D 02	1.226000E 02	1.226433E 02	-4.335022E-02	6
2.285000D 02	1.231000E 02	1.230307E 02	6.933594E-02	7
2.555000D 02	1.234000E 02	1.234511E 02	-5.108643E-02	8
2.815000D 02	1.239000E 02	1.238580E 02	4.200745E-02	9
2.980000D 02	1.241000E 02	1.241173E 02	-1.727295E-02	10

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.19561E 02

C_2 = 1.48422E-02

C_3 = 1.50532E-06

Statistical Terms

$$s_e = \sqrt{\sum (\text{Residuals})^2 / \text{d.f.}}$$

s_e = 4.741536E-02

d.f. = 7

t_α = 2.36

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.20758E 02	3.38678E-02	1.20620E 02	1.20895E 02	1.20678E 02	1.20838E 02
90.	1.20909E 02	2.84892E-02	1.20778E 02	1.21039E 02	1.20841E 02	1.20976E 02
100.	1.21060E 02	2.44029E-02	1.20934E 02	1.21186E 02	1.21002E 02	1.21117E 02
110.	1.21211E 02	2.17237E-02	1.21088E 02	1.21335E 02	1.21160E 02	1.21263E 02
120.	1.21363E 02	2.04426E-02	1.21242E 02	1.21485E 02	1.21315E 02	1.21412E 02
130.	1.21516E 02	2.02974E-02	1.21394E 02	1.21637E 02	1.21468E 02	1.21563E 02
140.	1.21668E 02	2.08910E-02	1.21546E 02	1.21790E 02	1.21619E 02	1.21717E 02
150.	1.21821E 02	2.18205E-02	1.21698E 02	1.21944E 02	1.21769E 02	1.21872E 02
160.	1.21974E 02	2.27774E-02	1.21850E 02	1.22098E 02	1.21920E 02	1.22028E 02
170.	1.22127E 02	2.35587E-02	1.22002E 02	1.22252E 02	1.22072E 02	1.22183E 02
180.	1.22281E 02	2.40457E-02	1.22156E 02	1.22406E 02	1.22224E 02	1.22338E 02
190.	1.22435E 02	2.41787E-02	1.22309E 02	1.22561E 02	1.22378E 02	1.22492E 02
200.	1.22589E 02	2.39446E-02	1.22464E 02	1.22715E 02	1.22533E 02	1.22646E 02
210.	1.22744E 02	2.33741E-02	1.22619E 02	1.22869E 02	1.22689E 02	1.22799E 02
220.	1.22899E 02	2.25481E-02	1.22775E 02	1.23023E 02	1.22846E 02	1.22952E 02
230.	1.23054E 02	2.16143E-02	1.22931E 02	1.23177E 02	1.23003E 02	1.23105E 02
240.	1.23209E 02	2.08112E-02	1.23087E 02	1.23332E 02	1.23160E 02	1.23259E 02
250.	1.23365E 02	2.04816E-02	1.23243E 02	1.23487E 02	1.23317E 02	1.23414E 02
260.	1.23521E 02	2.10372E-02	1.23399E 02	1.23644E 02	1.23472E 02	1.23571E 02
270.	1.23678E 02	2.28318E-02	1.23554E 02	1.23802E 02	1.23624E 02	1.23732E 02
280.	1.23834E 02	2.60294E-02	1.23707E 02	1.23962E 02	1.23773E 02	1.23896E 02
290.	1.23991E 02	3.05929E-02	1.23858E 02	1.24125E 02	1.23919E 02	1.24064E 02
300.	1.24149E 02	3.63882E-02	1.24008E 02	1.24290E 02	1.24063E 02	1.24235E 02

Table G-23

ELECTRICAL RESISTIVITY OF INCONEL*: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^oK)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.208000E 02	1.208468E 02	-4.681396E-02	1
9.750000D 01	1.211000E 02	1.211105E 02	-1.049805E-02	2
1.115000D 02	1.213000E 02	1.212977E 02	2.304077E-03	3
1.460000D 02	1.218000E 02	1.217713E 02	2.873230E-02	4
1.755000D 02	1.222000E 02	1.221901E 02	9.857178E-03	5
1.985000D 02	1.226000E 02	1.225256E 02	7.437134E-02	6
2.235000D 02	1.229000E 02	1.228991E 02	9.002686E-04	7
2.615000D 02	1.235000E 02	1.234844E 02	1.556396E-02	8
2.750000D 02	1.237000E 02	1.236975E 02	2.502441E-03	9
2.990000D 02	1.241000E 02	1.240829E 02	1.705933E-02	10
3.290000D 02	1.245000E 02	1.245767E 02	-7.665016E-02	11
3.705000D 02	1.252000E 02	1.252815E 02	-8.149719E-02	12
4.215000D 02	1.262000E 02	1.261824E 02	1.756287E-02	13
4.635000D 02	1.270000E 02	1.269532E 02	4.682927E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.19887E 02

C_2 = 1.18302E-02

C_3 = 7.36797E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 4.702146E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$s_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.20881E 02	2.87013E-02	1.20759E 02	1.21002E 02	1.20817E 02	1.20944E 02
100.	1.21144E 02	2.34519E-02	1.21029E 02	1.21259E 02	1.21092E 02	1.21195E 02
120.	1.21413E 02	1.95221E-02	1.21301E 02	1.21525E 02	1.21370E 02	1.21456E 02
140.	1.21688E 02	1.70424E-02	1.21578E 02	1.21798E 02	1.21650E 02	1.21725E 02
160.	1.21968E 02	1.59626E-02	1.21859E 02	1.22078E 02	1.21933E 02	1.22004E 02
180.	1.22255E 02	1.59532E-02	1.22145E 02	1.22364E 02	1.22220E 02	1.22290E 02
200.	1.22548E 02	1.65337E-02	1.22438E 02	1.22657E 02	1.22511E 02	1.22584E 02
220.	1.22846E 02	1.72823E-02	1.22735E 02	1.22956E 02	1.22808E 02	1.22884E 02
240.	1.23151E 02	1.79236E-02	1.23040E 02	1.23261E 02	1.23111E 02	1.23190E 02
260.	1.23461E 02	1.83140E-02	1.23350E 02	1.23572E 02	1.23421E 02	1.23501E 02
280.	1.23777E 02	1.84097E-02	1.23665E 02	1.23888E 02	1.23737E 02	1.23818E 02
300.	1.24099E 02	1.82510E-02	1.23988E 02	1.24210E 02	1.24059E 02	1.24139E 02
320.	1.24427E 02	1.79650E-02	1.24315E 02	1.24538E 02	1.24388E 02	1.24467E 02
340.	1.24761E 02	1.77801E-02	1.24650E 02	1.24872E 02	1.24722E 02	1.24800E 02
360.	1.25101E 02	1.80297E-02	1.24990E 02	1.25212E 02	1.25061E 02	1.25140E 02
380.	1.25446E 02	1.91007E-02	1.25335E 02	1.25558E 02	1.25404E 02	1.25488E 02
400.	1.25799E 02	2.13123E-02	1.25684E 02	1.25912E 02	1.25751E 02	1.25845E 02
420.	1.26155E 02	2.48091E-02	1.26039E 02	1.26272E 02	1.26101E 02	1.26210E 02
440.	1.26519E 02	2.95709E-02	1.26397E 02	1.26641E 02	1.26454E 02	1.26584E 02
460.	1.26888E 02	3.55013E-02	1.26758E 02	1.27018E 02	1.26810E 02	1.26966E 02

Table G-24

ELECTRICAL RESISTIVITY OF INCONEL*: POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.208000E 02	1.208765E 02	-7.652283E-02	1
9.750000D 01	1.209000E 02	1.208096E 02	-9.628296E-03	2
1.115000D 02	1.208000E 02	1.207696E 02	3.034973E-02	3
1.460000D 02	1.207000E 02	1.206942E 02	5.798340E-03	4
1.755000D 02	1.207000E 02	1.206558E 02	4.423523E-02	5
1.985000D 02	1.207000E 02	1.206425E 02	5.751038E-02	6
2.235000D 02	1.207000E 02	1.206447E 02	5.534363E-02	7
2.615000D 02	1.207000E 02	1.206810E 02	1.899719E-02	8
2.750000D 02	1.207000E 02	1.207035E 02	-3.524780E-03	9
2.990000D 02	1.207000E 02	1.207560E 02	-5.596924E-02	10
3.290000D 02	1.208000E 02	1.208439E 02	-4.396057E-02	11
3.705000D 02	1.209000E 02	1.210066E 02	-1.066437E-01	12
4.215000D 02	1.213000E 02	1.212717E 02	2.825928E-02	13
4.635000D 02	1.216000E 02	1.215440E 02	5.595398E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.212384E 02

C_2 = -5.744401E-03

C_3 = 1.381639E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 5.718470E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.20867E 02	3.49049E-02	1.20720E 02	1.21015E 02	1.20790E 02	1.20944E 02
100.	1.20802E 02	2.85208E-02	1.20661E 02	1.20943E 02	1.20739E 02	1.20865E 02
120.	1.20748E 02	2.37416E-02	1.20612E 02	1.20884E 02	1.20696E 02	1.20800E 02
140.	1.20705E 02	2.07260E-02	1.20571E 02	1.20839E 02	1.20659E 02	1.20751E 02
160.	1.20673E 02	1.94127E-02	1.20540E 02	1.20806E 02	1.20630E 02	1.20716E 02
180.	1.20652E 02	1.94014E-02	1.20519E 02	1.20785E 02	1.20609E 02	1.20695E 02
200.	1.20642E 02	2.01073E-02	1.20509E 02	1.20775E 02	1.20598E 02	1.20686E 02
220.	1.20643E 02	2.10177E-02	1.20509E 02	1.20777E 02	1.20597E 02	1.20690E 02
240.	1.20656E 02	2.17977E-02	1.20521E 02	1.20790E 02	1.20608E 02	1.20703E 02
260.	1.20679E 02	2.22724E-02	1.20544E 02	1.20814E 02	1.20630E 02	1.20728E 02
280.	1.20713E 02	2.23888E-02	1.20578E 02	1.20848E 02	1.20664E 02	1.20762E 02
300.	1.20759E 02	2.21957E-02	1.20624E 02	1.20893E 02	1.20710E 02	1.20807E 02
320.	1.20815E 02	2.18479E-02	1.20680E 02	1.20950E 02	1.20767E 02	1.20863E 02
340.	1.20882E 02	2.16231E-02	1.20748E 02	1.21017E 02	1.20835E 02	1.20930E 02
360.	1.20961E 02	2.19266E-02	1.20826E 02	1.21096E 02	1.20913E 02	1.21009E 02
380.	1.21051E 02	2.37791E-02	1.20915E 02	1.21186E 02	1.20999E 02	1.21102E 02
400.	1.21151E 02	2.59187E-02	1.21013E 02	1.21289E 02	1.21094E 02	1.21208E 02
420.	1.21263E 02	3.01713E-02	1.21121E 02	1.21405E 02	1.21197E 02	1.21329E 02
440.	1.21385E 02	3.59624E-02	1.21237E 02	1.21534E 02	1.21307E 02	1.21465E 02
460.	1.21519E 02	4.31746E-02	1.21362E 02	1.21677E 02	1.21424E 02	1.21614E 02

Table G-25

ELECTRICAL RESISTIVITY OF INCONEL*:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^{o}K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.12300	-0.04660	0.29060	0.03110	0.21389
100	0.08400	-0.07313	0.24113	0.01297	0.15502
120	0.05000	-0.10219	0.20219	-0.00932	0.10932
140	0.02000	-0.13113	0.17113	-0.03654	0.07654
160	-0.00600	-0.15780	0.14580	-0.06429	0.05229
180	-0.02600	-0.17865	0.12665	-0.08647	0.03447
200	-0.04100	-0.19385	0.11185	-0.10198	0.01998
220	-0.05300	-0.20529	0.09929	-0.11256	0.00656
240	-0.05800	-0.20954	0.09354	-0.11561	-0.00038
260	-0.06000	-0.21188	0.09188	-0.11851	-0.00148
280	-0.05700	-0.21227	0.09827	-0.12382	0.00982
300	-0.05000	-0.21404	0.11404	-0.13523	0.03523

Table G-26

ELECTRICAL RESISTIVITY OF INCONEL* DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	120.8	945.1	1.36(17)	120.9
11.0	1.58(15)	120.8	995.4	1.43(17)	120.9
15.7	2.26(15)	120.8	1049.7	1.51(17)	120.9
16.5	2.38(15)	120.8	1102.3	1.59(17)	120.9
26.1	3.76(15)	120.8	1166.2	1.68(17)	120.9
31.1	4.48(15)	120.8	1204.7	1.73(17)	120.9
34.9	5.03(15)	120.8	1214.3	1.75(17)	120.9
40.9	5.89(15)	120.8	1255.9	1.81(17)	121.0
59.0	8.50(15)	120.8	1307.1	1.88(17)	120.9
63.0	9.07(15)	120.7	1358.3	1.96(17)	120.9
71.8	1.03(16)	120.8	1409.5	2.03(17)	120.9
81.0	1.17(16)	120.8	1460.7	2.10(17)	120.9
82.1	1.18(16)[b]	120.7	1512.5	2.18(17)	120.9
90.1	1.30(16)	120.8	1563.1	2.25(17)	120.9
128.3	1.85(16)	120.8	1613.1	2.32(17)	120.9
164.8	2.37(16)	120.8	1662.7	2.39(17)	120.9
197.6	2.85(16)	120.8	1711.9	2.47(17)	120.9
234.8	3.38(16)	120.8	1756.7	2.53(17)	120.9
235.0	3.38(16)	120.8	1807.9	2.60(17)	120.9
237.8	3.42(16)	120.8	1859.2	2.68(17)	120.9
273.8	3.94(16)	120.8	1899.1	2.73(17)	120.9
309.7	4.46(16)	120.8	1902.4	2.74(17)[b]	120.7
317.2	4.57(16)	120.9	1902.4	2.74(17)[b]	120.9
373.3	5.38(16)	120.9	1902.4	2.74(17)[b]	120.7
431.5	6.21(16)	120.9	1902.4	2.74(17)[b]	120.7
491.5	7.08(16)	120.9	1902.4	2.74(17)[b]	120.7
593.6	8.55(16)	120.9	1902.4	2.74(17)[b]	120.8
610.2	8.79(16)	120.9	1902.4	2.74(17)[b]	120.8
639.2	9.20(16)[b]	120.7	1902.4	2.74(17)[b]	120.8
641.3	9.23(16)	120.8	1905.8	2.74(17)	120.8
666.5	9.60(16)	120.8	1925.4	2.77(17)	120.8
674.1	9.71(16)[b]	120.7	1960.3	2.82(17)	120.8
674.1	9.71(16)[b]	120.7	2000.3	2.88(17)	120.8
674.1	9.71(16)[b]	120.7	2046.1	2.95(17)	120.8
674.1	9.71(16)[b]	120.7	2080.3	3.00(17)	120.8
725.7	1.05(17)	120.9	2120.3	3.05(17)	120.8
777.4	1.12(17)	120.9	2158.6	3.11(17)	120.8
811.7	1.17(17)	120.9	2200.3	3.17(17)	120.8
867.8	1.25(17)	120.9	2237.1	3.22(17)	120.8
902.6	1.30(17)[b]	120.7	2305.0	3.32(17)	120.8
902.6	1.30(17)[b]	120.7	2309.8	3.33(17)	120.8
902.6	1.30(17)[b]	120.7			

[a] Neutron fluence for 1 > MeV
[b] Reactor at zero power

Table G-27

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1): PREIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	2.224999E 00	2.206948E 00	1.805115E-02	1
9.600000D 01	2.422999E 00	2.429360E 00	-6.361008E-03	2
1.185000D 02	2.683999E 00	2.698223E 00	-1.422405E-02	3
1.405000D 02	2.950999E 00	2.960917E 00	-9.918213E-03	4
1.695000D 02	3.306999E 00	3.306902E 00	9.727478E-05	5
2.015000D 02	3.688999E 00	3.688291E 00	7.085800E-04	6
2.255000D 02	3.983999E 00	3.974067E 00	9.932518E-03	7
2.520000D 02	4.299000E 00	4.289344E 00	9.655952E-03	8
2.775000D 02	4.605000E 00	4.592462E 00	1.253796E-02	9
2.940000D 02	4.768000E 00	4.788460E 00	-2.046013E-02	10

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

$C_1 = 1.27996E\ 00$

$C_2 = 1.19920E-02$

$C_3 = -1.98385E-07$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.431892E-02$

d.f. = 7

$t_\alpha = 2.36$

$\alpha = 0.05$

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.23805E 00	1.02152E-02	2.19654E 00	2.27956E 00	2.21394E 00	2.26215E 00
90.	2.35763E 00	8.57097E-03	2.31825E 00	2.39701E 00	2.33740E 00	2.37786E 00
100.	2.47717E 00	7.33143E-03	2.43921E 00	2.51514E 00	2.45987E 00	2.49447E 00
110.	2.59668E 00	6.53309E-03	2.55953E 00	2.63382E 00	2.58126E 00	2.61209E 00
120.	2.71614E 00	6.16435E-03	2.67935E 00	2.75293E 00	2.70159E 00	2.73069E 00
130.	2.83556E 00	6.14210E-03	2.79879E 00	2.87233E 00	2.82107E 00	2.85006E 00
140.	2.95495E 00	6.33721E-03	2.91799E 00	2.99190E 00	2.93999E 00	2.96990E 00
150.	3.07429E 00	6.62441E-03	3.03706E 00	3.11153E 00	3.05866E 00	3.08993E 00
160.	3.19360E 00	6.91006E-03	3.15608E 00	3.23112E 00	3.17729E 00	3.20991E 00
170.	3.31286E 00	7.13473E-03	3.27511E 00	3.35062E 00	3.29603E 00	3.32970E 00
180.	3.43209E 00	7.26248E-03	3.39420E 00	3.46998E 00	3.41495E 00	3.44923E 00
190.	3.55128E 00	7.27847E-03	3.51337E 00	3.58918E 00	3.53410E 00	3.56845E 00
200.	3.67042E 00	7.18125E-03	3.63262E 00	3.70823E 00	3.65348E 00	3.68737E 00
210.	3.78953E 00	6.98371E-03	3.75193E 00	3.82713E 00	3.77305E 00	3.80601E 00
220.	3.90860E 00	6.71655E-03	3.87127E 00	3.94592E 00	3.89275E 00	3.92445E 00
230.	4.02762E 00	6.43404E-03	3.99058E 00	4.06467E 00	4.01244E 00	4.04281E 00
240.	4.14661E 00	6.22187E-03	4.10977E 00	4.18346E 00	4.13193E 00	4.16129E 00
250.	4.26556E 00	6.19849E-03	4.22874E 00	4.30238E 00	4.25093E 00	4.28019E 00
260.	4.38447E 00	6.49396E-03	4.34736E 00	4.42157E 00	4.36914E 00	4.39979E 00
270.	4.50334E 00	7.20258E-03	4.46551E 00	4.54116E 00	4.48634E 00	4.52033E 00
280.	4.62217E 00	8.35090E-03	4.58305E 00	4.66128E 00	4.60246E 00	4.64187E 00
290.	4.74096E 00	9.91122E-03	4.69986E 00	4.78205E 00	4.71756E 00	4.76435E 00
300.	4.85970E 00	1.18372E-02	4.81586E 00	4.90355E 00	4.83177E 00	4.88764E 00

Table G-28

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1): POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^{o}K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	2.337000E 00	2.297341E 00	3.965855E-02	1
9.650000D 01	2.497000E 00	2.511122E 00	-1.412201E-02	2
1.095000D 02	2.634999E 00	2.657046E 00	-2.204704E-02	3
1.445000D 02	3.042999E 00	3.051609E 00	-8.609772E-03	4
1.735000D 02	3.375999E 00	3.380399E 00	-4.399300E-03	5
1.960000D 02	3.624000E 00	3.636660E 00	-1.266003E-02	6
2.205000D 02	3.908999E 00	3.916856E 00	-7.856369E-03	7
2.575000D 02	4.351999E 00	4.342299E 00	9.699821E-03	8
2.700000D 02	4.502999E 00	4.486651E 00	1.634789E-02	9
2.940000D 02	4.773000E 00	4.764689E 00	8.310318E-03	10
3.245000D 02	5.125000E 00	5.119701E 00	5.298615E-03	11
3.645000D 02	5.591999E 00	5.588125E 00	3.873825E-03	12
4.165000D 02	6.186999E 00	6.201887E 00	-1.488781E-02	13
4.585000D 02	6.702999E 00	6.701586E 00	1.413345E-03	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 1.43854E 00

C_2 = 1.10178E-02

C_3 = 1.00545E-06

Statistical Terms

$$s_e = \sqrt{\Sigma(\text{Residuals})^2/\text{d.f.}}$$

s_e = 1.724400E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (^{o}K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.32640E 00	1.04510E-02	2.28204E 00	2.37076E 00	2.30341E 00	2.34939E 00
100.	2.55037E 00	8.51889E-03	2.50806E 00	2.59269E 00	2.53163E 00	2.56912E 00
120.	2.77516E 00	7.08402E-03	2.73414E 00	2.81617E 00	2.75957E 00	2.79074E 00
140.	3.00074E 00	6.19449E-03	2.96043E 00	3.04105E 00	2.98711E 00	3.01437E 00
160.	3.22713E 00	5.82595E-03	3.18709E 00	3.26717E 00	3.21431E 00	3.23995E 00
180.	3.45433E 00	5.84726E-03	3.41427E 00	3.49438E 00	3.44146E 00	3.46719E 00
200.	3.68232E 00	6.07518E-03	3.64210E 00	3.72255E 00	3.66896E 00	3.69569E 00
220.	3.91113E 00	6.35411E-03	3.87070E 00	3.95156E 00	3.89715E 00	3.92511E 00
240.	4.14073E 00	6.58530E-03	4.10012E 00	4.18134E 00	4.12625E 00	4.15522E 00
260.	4.37115E 00	6.71926E-03	4.33043E 00	4.41186E 00	4.35636E 00	4.38593E 00
280.	4.60236E 00	6.74391E-03	4.56163E 00	4.64310E 00	4.58752E 00	4.61720E 00
300.	4.83438E 00	6.67927E-03	4.79370E 00	4.87506E 00	4.81969E 00	4.84908E 00
320.	5.06721E 00	6.57950E-03	5.02660E 00	5.10781E 00	5.05273E 00	5.08168E 00
340.	5.30083E 00	6.53804E-03	5.26026E 00	5.34140E 00	5.28645E 00	5.31522E 00
360.	5.53527E 00	6.68653E-03	5.49458E 00	5.57596E 00	5.52056E 00	5.54998E 00
380.	5.77050E 00	7.16946E-03	5.72942E 00	5.81159E 00	5.75473E 00	5.78628E 00
400.	6.00655E 00	8.09526E-03	5.96464E 00	6.04845E 00	5.98874E 00	6.02435E 00
420.	6.24339E 00	9.50317E-03	6.20008E 00	6.28671E 00	6.22249E 00	6.26430E 00
440.	6.48104E 00	1.13767E-02	6.43559E 00	6.52649E 00	6.45601E 00	6.50607E 00
460.	6.71950E 00	1.36778E-02	6.67108E 00	6.76792E 00	6.68941E 00	6.74959E 00

Table G-29

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1): POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	2.337000E 00	2.330070E 00	6.930351E-03	1
9.650000D 01	2.332999E 00	2.325059E 00	7.940292E-03	2
1.095000D 02	2.327000E 00	2.321344E 00	5.655289E-03	3
1.445000D 02	2.313000E 00	2.310113E 00	2.886772E-03	4
1.735000D 02	2.285999E 00	2.299448E 00	-1.344872E-02	5
1.960000D 02	2.270000E 00	2.290325E 00	-2.032566E-02	6
2.205000D 02	2.264999E 00	2.279551E 00	-1.455115E-02	7
2.575000D 02	2.257999E 00	2.261613E 00	-3.613472E-03	8
2.700000D 02	2.252999E 00	2.255100E 00	-2.100945E-03	9
2.940000D 02	2.242999E 00	2.241954E 00	1.045227E-03	10
3.245000D 02	2.235999E 00	2.224032E 00	1.196671E-02	11
3.645000D 02	2.224000E 00	2.198465E 00	2.553463E-02	12
4.165000D 02	2.190000E 00	2.161728E 00	2.827168E-02	13
4.585000D 02	2.092999E 00	2.129168E 00	-3.616810E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 2.34491E 00

C_2 = -1.35078E-04

C_3 = -7.31642E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 1.877699E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.32942E 00	1.13801E-02	2.28111E 00	2.37772E 00	2.30438E 00	2.35445E 00
100.	2.32408E 00	9.27622E-03	2.27801E 00	2.37016E 00	2.30368E 00	2.34449E 00
120.	2.31816E 00	7.71379E-03	2.27350E 00	2.36282E 00	2.30119E 00	2.33513E 00
140.	2.31166E 00	6.74519E-03	2.26775E 00	2.35555E 00	2.29682E 00	2.32650E 00
160.	2.30457E 00	6.34388E-03	2.26095E 00	2.34817E 00	2.29061E 00	2.31852E 00
180.	2.29689E 00	6.36708E-03	2.25327E 00	2.34051E 00	2.28288E 00	2.31090E 00
200.	2.28863E 00	6.61526E-03	2.24483E 00	2.33242E 00	2.27407E 00	2.30318E 00
220.	2.27978E 00	6.91899E-03	2.23575E 00	2.32380E 00	2.26456E 00	2.29500E 00
240.	2.27035E 00	7.17073E-03	2.22613E 00	2.31457E 00	2.25457E 00	2.28612E 00
260.	2.26033E 00	7.31660E-03	2.21599E 00	2.30466E 00	2.24423E 00	2.27642E 00
280.	2.24972E 00	7.34344E-03	2.20537E 00	2.29408E 00	2.23357E 00	2.26588E 00
300.	2.23854E 00	7.27306E-03	2.19424E 00	2.28284E 00	2.22254E 00	2.25454E 00
320.	2.22676E 00	7.16442E-03	2.18255E 00	2.27098E 00	2.21100E 00	2.24252E 00
340.	2.21440E 00	7.11927E-03	2.17022E 00	2.25858E 00	2.19874E 00	2.23007E 00
360.	2.20146E 00	7.28096E-03	2.15715E 00	2.24576E 00	2.18544E 00	2.21748E 00
380.	2.18793E 00	7.80683E-03	2.14319E 00	2.23267E 00	2.17075E 00	2.20510E 00
400.	2.17381E 00	8.81493E-03	2.12818E 00	2.21945E 00	2.15442E 00	2.19321E 00
420.	2.15911E 00	1.03480E-02	2.11195E 00	2.20628E 00	2.13635E 00	2.18188E 00
440.	2.14383E 00	1.23881E-02	2.09434E 00	2.19332E 00	2.11657E 00	2.17108E 00
460.	2.12796E 00	1.48937E-02	2.07523E 00	2.18068E 00	2.09519E 00	2.16072E 00

Table G-30

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1):
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (°K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.08835	0.03074	0.14595	0.05655	0.12014
100	0.07320	0.01942	0.12697	0.04903	0.09736
120	0.05902	0.00690	0.11113	0.03880	0.07923
140	0.04579	-0.00600	0.09758	0.02642	0.06515
160	0.03353	-0.01850	0.08556	0.01352	0.05353
180	0.02224	-0.03007	0.07455	0.00151	0.04296
200	0.01190	-0.04045	0.06425	-0.00891	0.03271
220	0.00253	-0.04960	0.05466	-0.01773	0.02279
240	-0.00588	-0.05777	0.04601	-0.02552	0.01376
260	-0.01332	-0.06547	0.03883	-0.03362	0.00698
280	-0.01981	-0.07344	0.03382	-0.04366	0.00404
300	-0.02532	-0.08249	0.03185	-0.05632	0.00568

Table G-31

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1) DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	2.228	945.1	1.36(17)	2.277
11.0	1.58(15)	2.228	995.4	1.43(17)	2.281
15.7	2.26(15)	2.227	1049.7	1.51(17)	2.281
16.5	2.38(15)	2.228	1102.3	1.59(17)	2.284
26.1	3.76(15)	2.229	1166.2	1.68(17)	2.285
31.1	4.48(15)	2.230	1204.7	1.73(17)	2.289
34.9	5.03(15)	2.230	1214.3	1.75(17)	2.289
40.9	5.89(15)	2.230	1255.9	1.81(17)	2.291
59.0	8.50(15)	2.231	1307.1	1.88(17)	2.294
63.0	9.07(15)	2.224	1358.3	1.96(17)	2.297
71.8	1.03(16)	2.233	1409.5	2.03(17)	2.298
81.0	1.17(16)	2.230	1460.7	2.10(17)	2.302
82.1	1.18(16)[b]	2.227	1512.5	2.18(17)	2.303
90.1	1.30(16)	2.232	1563.1	2.25(17)	2.306
128.3	1.85(16)	2.234	1613.1	2.32(17)	2.307
164.8	2.37(16)	2.235	1662.7	2.39(17)	2.311
197.6	2.85(16)	2.237	1711.9	2.47(17)	2.314
234.8	3.38(16)	2.238	1756.7	2.53(17)	2.315
235.0	3.38(16)	2.238	1807.9	2.60(17)	2.317
237.8	3.42(16)	2.240	1859.2	2.68(17)	2.319
273.8	3.94(16)	2.242	1899.1	2.73(17)	2.320
309.7	4.46(16)	2.245	1902.4	2.74(17)[b]	2.316
317.2	4.57(16)	2.244	1902.4	2.74(17)[b]	2.319
373.3	5.38(16)	2.248	1902.4	2.74(17)[b]	2.318
431.5	6.21(16)	2.251	1902.4	2.74(17)[b]	2.317
491.5	7.08(16)	2.255	1902.4	2.74(17)[b]	2.318
593.6	8.55(16)	2.259	1902.4	2.74(17)[b]	2.317
610.2	8.79(16)	2.261	1902.4	2.74(17)[b]	2.317
639.2	9.20(16)[b]	2.259	1902.4	2.74(17)[b]	2.315
641.3	9.23(16)	2.261	1905.8	2.74(17)	2.318
666.5	9.60(16)	2.263	1925.4	2.77(17)	2.323
674.1	9.71(16)[b]	2.260	1960.3	2.82(17)	2.321
674.1	9.71(16)[b]	2.260	2000.3	2.88(17)	2.325
674.1	9.71(16)[b]	2.260	2046.1	2.95(17)	2.327
674.1	9.71(16)[b]	2.259	2080.3	3.00(17)	2.330
725.7	1.05(17)	2.266	2120.3	3.05(17)	2.331
777.4	1.12(17)	2.270	2158.6	3.11(17)	2.333
811.7	1.17(17)	2.271	2200.3	3.17(17)	2.334
867.8	1.25(17)	2.272	2237.1	3.22(17)	2.338
902.6	1.30(17)[b]	2.271	2305.0	3.32(17)	2.338
902.6	1.30(17)[b]	2.270	2309.8	3.33(17)	2.338
902.6	1.30(17)[b]	2.270			

[a] Neutron fluence for 1 > MeV
[b] Reactor at zero power

Table G-32

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(1): DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	2.224999E 00	2.225513E 00	-5.140305E-04	0
1.180000D-01	2.226999E 00	2.229506E 00	-2.507210E-03	1
9.200000D-01	2.259000E 00	2.256647E 00	2.352715E-03	2
9.710000D-01	2.259999E 00	2.258373E 00	1.626015E-03	3
1.299999D 00	2.270000E 00	2.269506E 00	4.930496E-04	4
2.740000D 00	2.316999E 00	2.318238E 00	-1.238823E-03	5
3.330000D 00	2.337999E 00	2.338205E 00	-2.059937E-04	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

$C_1 = 2.22551E\ 00$

$C_2 = 3.38414E-19$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.819325E-03$

d.f. = 5

$t_\alpha = 2.57$

$\alpha = 0.05$

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	2.22551E 00	1.04729E-03	2.22012E 00	2.23091E 00	2.22282E 00	2.22820E 00
4.000E-01	2.23905E 00	8.83101E-04	2.23385E 00	2.24425E 00	2.23678E 00	2.24132E 00
8.000E-01	2.25259E 00	7.57724E-04	2.24752E 00	2.25765E 00	2.25064E 00	2.25453E 00
1.200E 00	2.26612E 00	6.92565E-04	2.26112E 00	2.27113E 00	2.26434E 00	2.26790E 00
1.600E 00	2.27966E 00	7.04535E-04	2.27464E 00	2.28467E 00	2.27785E 00	2.28147E 00
2.000E 00	2.29320E 00	7.90136E-04	2.28810E 00	2.29829E 00	2.29116E 00	2.29523E 00
2.400E 00	2.30673E 00	9.29237E-04	2.30148E 00	2.31198E 00	2.30434E 00	2.30912E 00
2.800E 00	2.32027E 00	1.10176E-03	2.31480E 00	2.32573E 00	2.31744E 00	2.32310E 00
3.200E 00	2.33381E 00	1.29440E-03	2.32807E 00	2.33954E 00	2.33048E 00	2.33713E 00

Table G-33

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2): PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	2.158999E 00	2.142765E 00	1.623440E-02	1
9.600000D 01	2.355000E 00	2.363324E 00	-8.324623E-03	2
1.185000D 02	2.620000E 00	2.630787E 00	-1.078701E-02	3
1.405000D 02	2.884000E 00	2.893004E 00	-9.004593E-03	4
1.695000D 02	3.242999E 00	3.239708E 00	3.291130E-03	5
2.020000D 02	3.629000E 00	3.629680E 00	-6.799698E-04	6
2.260000D 02	3.931000E 00	3.918624E 00	1.237583E-02	7
2.525000D 02	4.242000E 00	4.238622E 00	3.377914E-03	8
2.785000D 02	4.558000E 00	4.553553E 00	4.446983E-03	9
2.950000D 02	4.742999E 00	4.753914E 00	-1.091480E-02	10

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

$C_1 = 1.23025E\ 00$

$C_2 = 1.17344E-02$

$C_3 = 7.12489E-07$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 1.098746E-02$

d.f. = 7

$t_\alpha = 2.36$

$\alpha = 0.05$

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	2.17357E 00	7.83032E-03	2.14172E 00	2.20541E 00	2.15509E 00	2.19205E 00
90.	2.29212E 00	6.57417E-03	2.26190E 00	2.32234E 00	2.27661E 00	2.30764E 00
100.	2.41082E 00	5.62589E-03	2.38169E 00	2.43995E 00	2.39754E 00	2.42410E 00
110.	2.52966E 00	5.01335E-03	2.50116E 00	2.55816E 00	2.51783E 00	2.54149E 00
120.	2.64864E 00	4.72828E-03	2.62041E 00	2.67687E 00	2.63748E 00	2.65980E 00
130.	2.76777E 00	4.70836E-03	2.73956E 00	2.79598E 00	2.75666E 00	2.77888E 00
140.	2.88704E 00	4.85590E-03	2.85869E 00	2.91539E 00	2.87558E 00	2.89850E 00
150.	3.00645E 00	5.07551E-03	2.97788E 00	3.03501E 00	2.99447E 00	3.01843E 00
160.	3.12600E 00	5.29562E-03	3.09721E 00	3.15479E 00	3.11350E 00	3.13850E 00
170.	3.24570E 00	5.46996E-03	3.21673E 00	3.27466E 00	3.23279E 00	3.25861E 00
180.	3.36553E 00	5.57195E-03	3.33646E 00	3.39461E 00	3.35238E 00	3.37868E 00
190.	3.48551E 00	5.58890E-03	3.45642E 00	3.51461E 00	3.47232E 00	3.49870E 00
200.	3.60564E 00	5.51937E-03	3.57662E 00	3.63465E 00	3.59261E 00	3.61866E 00
210.	3.72590E 00	5.37281E-03	3.69704E 00	3.75477E 00	3.71322E 00	3.73858E 00
220.	3.84631E 00	5.17145E-03	3.81765E 00	3.87497E 00	3.83411E 00	3.85852E 00
230.	3.96686E 00	4.95503E-03	3.93842E 00	3.99531E 00	3.95517E 00	3.97855E 00
240.	4.08755E 00	4.78664E-03	4.05927E 00	4.11584E 00	4.07626E 00	4.09885E 00
250.	4.20839E 00	4.75431E-03	4.18014E 00	4.23664E 00	4.19717E 00	4.21961E 00
260.	4.32937E 00	4.95662E-03	4.30092E 00	4.35781E 00	4.31767E 00	4.34106E 00
270.	4.45049E 00	5.46867E-03	4.42152E 00	4.47945E 00	4.43758E 00	4.46339E 00
280.	4.57175E 00	6.31550E-03	4.54184E 00	4.60166E 00	4.55685E 00	4.58666E 00
290.	4.69216E 00	7.47850E-03	4.66179E 00	4.72452E 00	4.67551E 00	4.71081E 00
300.	4.81470E 00	8.92295E-03	4.78130E 00	4.84811E 00	4.79365E 00	4.83576E 00

Table G-34

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2): POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	2.290999E 00	2.298985E 00	-7.986069E-03	1
9.700000D 01	2.535000E 00	2.530252E 00	4.748344E-03	2
1.095000D 02	2.686000E 00	2.677320E 00	8.679390E-03	3
1.445000D 02	3.094999E 00	3.087372E 00	7.627487E-03	4
1.740000D 02	3.427999E 00	3.430989E 00	-2.989769E-03	5
1.965000D 02	3.683000E 00	3.691844E 00	-8.844376E-03	6
2.215000D 02	3.973000E 00	3.980435E 00	-7.435799E-03	7
2.590000D 02	4.407000E 00	4.410865E 00	-3.865242E-03	8
2.715000D 02	4.556000E 00	4.553686E 00	2.313614E-03	9
2.955000D 02	4.825999E 00	4.826982E 00	-9.822845E-04	10
3.260000D 02	5.174000E 00	5.172553E 00	1.446724E-03	11
3.665000D 02	5.634000E 00	5.628408E 00	5.591393E-03	12
4.180000D 02	6.217999E 00	6.203105E 00	1.489449E-02	13
4.605000D 02	6.660000E 00	6.673178E 00	-1.317787E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2 T + C_3 T^2$$

C_1 = 1.37785E 00

C_2 = 1.19822E-02

C_3 = -1.04915E-06

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 8.593880E-03

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.32971E 00	5.21052E-03	2.30760E 00	2.35182E 00	2.31825E 00	2.34117E 00
100.	2.56558E 00	4.25131E-03	2.54448E 00	2.58667E 00	2.55622E 00	2.57493E 00
120.	2.80061E 00	3.53763E-03	2.78016E 00	2.82105E 00	2.79282E 00	2.80839E 00
140.	3.03479E 00	3.09330E-03	3.01470E 00	3.05489E 00	3.02799E 00	3.04160E 00
160.	3.26814E 00	2.90689E-03	3.24819E 00	3.28810E 00	3.26175E 00	3.27454E 00
180.	3.50066E 00	2.91459E-03	3.48069E 00	3.52062E 00	3.49424E 00	3.50707E 00
200.	3.73233E 00	3.02629E-03	3.71228E 00	3.75237E 00	3.72567E 00	3.73898E 00
220.	3.96316E 00	3.16486E-03	3.94301E 00	3.98330E 00	3.95619E 00	3.97012E 00
240.	4.19315E 00	3.28088E-03	4.17291E 00	4.21339E 00	4.18593E 00	4.20037E 00
260.	4.42230E 00	3.34927E-03	4.40201E 00	4.44259E 00	4.41493E 00	4.42967E 00
280.	4.65062E 00	3.36337E-03	4.63031E 00	4.67092E 00	4.64322E 00	4.65802E 00
300.	4.87809E 00	3.33227E-03	4.85781E 00	4.89837E 00	4.87076E 00	4.88542E 00
320.	5.10473E 00	3.28154E-03	5.08449E 00	5.12496E 00	5.09751E 00	5.11195E 00
340.	5.33052E 00	3.25605E-03	5.31030E 00	5.35074E 00	5.32336E 00	5.33768E 00
360.	5.55548E 00	3.31964E-03	5.53521E 00	5.57575E 00	5.54817E 00	5.56278E 00
380.	5.77959E 00	3.54382E-03	5.75914E 00	5.80005E 00	5.77180E 00	5.78739E 00
400.	6.00287E 00	3.98425E-03	5.98203E 00	6.02371E 00	5.99411E 00	6.01164E 00
420.	6.22531E 00	4.66288E-03	6.20380E 00	6.24682E 00	6.21505E 00	6.23557E 00
440.	6.44691E 00	5.57312E-03	6.42438E 00	6.46944E 00	6.43465E 00	6.45917E 00
460.	6.66767E 00	6.69644E-03	6.64370E 00	6.69164E 00	6.65294E 00	6.68240E 00

Table G-35

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2): POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	2.290999E 00	2.293102E 00	-2.102852E-03	1
9.700000D 01	2.287999E 00	2.281026E 00	6.973267E-03	2
1.095000D 02	2.280000E 00	2.273470E 00	6.529808E-03	3
1.445000D 02	2.263000E 00	2.252911E 00	1.008892E-02	4
1.740000D 02	2.228999E 00	2.236268E 00	-7.268906E-03	5
1.965000D 02	2.204000E 00	2.223996E 00	-1.999664E-02	6
2.215000D 02	2.198000E 00	2.210791E 00	-1.279068E-02	7
2.590000D 02	2.188999E 00	2.191825E 00	-2.825737E-03	8
2.715000D 02	2.186000E 00	2.185729E 00	2.708435E-04	9
2.955000D 02	2.176999E 00	2.174340E 00	2.658844E-03	10
3.260000D 02	2.169999E 00	2.160467E 00	9.531975E-03	11
3.665000D 02	2.158000E 00	2.143081E 00	1.491928E-02	12
4.180000D 02	2.136999E 00	2.122682E 00	1.431751E-02	13
4.605000D 02	2.087000E 00	2.107288E 00	-2.028847E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 2.34350E 00

C_2 = -6.79007E-04

C_3 = 3.60622E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 1.264537E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	2.29148E 00	7.66697E-03	2.25895E 00	2.32402E 00	2.27462E 00	2.30835E 00
100.	2.27920E 00	6.25554E-03	2.24816E 00	2.31024E 00	2.26544E 00	2.29296E 00
120.	2.26721E 00	5.20540E-03	2.23712E 00	2.29729E 00	2.25576E 00	2.27866E 00
140.	2.25550E 00	4.55160E-03	2.22594E 00	2.28507E 00	2.24549E 00	2.26552E 00
160.	2.24409E 00	4.27731E-03	2.21472E 00	2.27346E 00	2.23468E 00	2.25350E 00
180.	2.23296E 00	4.28864E-03	2.20358E 00	2.26234E 00	2.22352E 00	2.24239E 00
200.	2.22212E 00	4.45300E-03	2.19263E 00	2.25161E 00	2.21232E 00	2.23192E 00
220.	2.21157E 00	4.65690E-03	2.18192E 00	2.24122E 00	2.20132E 00	2.22181E 00
240.	2.20131E 00	4.82762E-03	2.17153E 00	2.23108E 00	2.19069E 00	2.21193E 00
260.	2.19133E 00	4.92824E-03	2.16148E 00	2.22119E 00	2.18049E 00	2.20218E 00
280.	2.18165E 00	4.94900E-03	2.15177E 00	2.21152E 00	2.17076E 00	2.19254E 00
300.	2.17225E 00	4.90323E-03	2.14241E 00	2.20209E 00	2.16146E 00	2.18304E 00
320.	2.16314E 00	4.82859E-03	2.13336E 00	2.19292E 00	2.15252E 00	2.17377E 00
340.	2.15432E 00	4.79108E-03	2.12457E 00	2.18407E 00	2.14378E 00	2.16486E 00
360.	2.14579E 00	4.88465E-03	2.11597E 00	2.17561E 00	2.13504E 00	2.15654E 00
380.	2.13755E 00	5.21451E-03	2.10746E 00	2.16764E 00	2.12608E 00	2.14902E 00
400.	2.12959E 00	5.86259E-03	2.09893E 00	2.16026E 00	2.11670E 00	2.14249E 00
420.	2.12193E 00	6.86115E-03	2.09028E 00	2.15358E 00	2.10683E 00	2.13702E 00
440.	2.11455E 00	8.20050E-03	2.08139E 00	2.14771E 00	2.09651E 00	2.13259E 00
460.	2.10746E 00	9.85347E-03	2.07219E 00	2.14273E 00	2.08578E 00	2.12914E 00

Table G-37

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2) DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	2.163	945.1	1.36(17)	2.223
11.0	1.58(15)	2.157	995.4	1.43(17)	2.218
15.7	2.26(15)	2.161	1049.7	1.51(17)	2.227
16.5	2.38(15)	2.162	1102.3	1.59(17)	2.230
26.1	3.76(15)	2.165	1166.2	1.68(17)	2.234
31.1	4.48(15)	2.165	1204.7	1.73(17)	2.234
34.9	5.03(15)	2.166	1214.3	1.75(17)	2.237
40.9	5.89(15)	2.163	1255.9	1.81(17)	2.241
59.0	8.50(15)	2.167	1307.1	1.88(17)	2.249
63.0	9.07(15)	2.162	1358.3	1.96(17)	2.247
71.8	1.03(16)	2.168	1409.5	2.03(17)	2.251
81.0	1.17(16)	2.166	1460.7	2.10(17)	2.250
82.1	1.18(16)[b]	2.165	1512.5	2.18(17)	2.254
90.1	1.30(16)	2.169	1563.1	2.25(17)	2.255
128.3	1.85(16)	2.169	1613.1	2.32(17)	2.257
164.8	2.37(16)	2.170	1662.7	2.39(17)	2.261
197.6	2.85(16)	2.175	1711.9	2.47(17)	2.267
234.8	3.38(16)	2.176	1756.7	2.53(17)	2.269
235.0	3.38(16)	2.177	1807.9	2.60(17)	2.270
237.8	3.42(16)	2.177	1859.2	2.68(17)	2.275
273.8	3.94(16)	2.181	1899.1	2.73(17)	2.274
309.7	4.46(16)	2.182	1902.4	2.74(17)[b]	2.269
317.2	4.57(16)	2.186	1902.4	2.74(17)[b]	2.256
373.3	5.38(16)	2.186	1902.4	2.74(17)[b]	2.269
431.5	6.21(16)	2.192	1902.4	2.74(17)[b]	2.269
491.5	7.08(16)	2.196	1902.4	2.74(17)[b]	2.197
593.6	8.55(16)	2.206	1902.4	2.74(17)[b]	2.269
610.2	8.79(16)	2.205	1902.4	2.74(17)[b]	2.269
639.2	9.20(16)[b]	2.200	1902.4	2.74(17)[b]	2.273
641.3	9.23(16)	2.203	1905.8	2.74(17)	2.272
666.5	9.60(16)	2.203	1925.4	2.77(17)	2.275
674.1	9.71(16)[b]	2.202	1960.3	2.82(17)	2.275
674.1	9.71(16)[b]	2.203	2000.3	2.88(17)	2.289
674.1	9.71(16)[b]	2.203	2046.1	2.95(17)	2.280
674.1	9.71(16)[b]	2.202	2080.3	3.00(17)	2.283
725.7	1.05(17)	2.210	2120.3	3.05(17)	2.282
777.4	1.12(17)	2.214	2158.6	3.11(17)	2.286
811.7	1.17(17)	2.217	2200.3	3.17(17)	2.286
867.8	1.25(17)	2.217	2237.1	3.22(17)	2.288
902.6	1.30(17)[b]	2.219	2305.0	3.32(17)	2.294
902.6	1.30(17)[b]	2.215	2309.8	3.33(17)	2.293
902.6	1.30(17)[b]	2.215			

[a] Neutron Fluence for 1 > MeV
[b] Reactor at zero power

Table G-36

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2): CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (°K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.15614	0.12196	0.19031	0.13728	0.17499
100	0.15476	0.12285	0.18666	0.14041	0.16910
120	0.15197	0.12104	0.18289	0.13996	0.16397
140	0.14775	0.11702	0.17847	0.13626	0.15923
160	0.14214	0.11127	0.17300	0.13027	0.15400
180	0.13513	0.10409	0.16616	0.12283	0.14742
200	0.12669	0.09562	0.15775	0.11432	0.13905
220	0.11685	0.08591	0.14778	0.10480	0.12889
240	0.10560	0.07480	0.13639	0.09392	0.11727
260	0.09293	0.06200	0.12385	0.08091	0.10494
280	0.07887	0.04711	0.11062	0.06485	0.09288
300	0.06339	0.02961	0.09716	0.04525	0.08152

Table G-38

ELECTRICAL RESISTIVITY OF ALUMINUM 7039-T61(2): DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data: Fluence (10^{17} n/cm^2)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
0.0	2.158999E 00	2.162284E 00	-3.284454E-03	0
1.187000D-01	2.165000E 00	2.166814E 00	-1.813889E-03	1
9.200000D-01	2.200000E 00	2.197606E 00	2.393723E-03	2
9.710000D-01	2.202499E 00	2.199565E 00	2.934456E-03	3
1.299999D 00	2.216299E 00	2.212196E 00	4.102707E-03	4
2.740000D 00	2.260300E 00	2.257485E 00	-7.184982E-03	5
3.330000D 00	2.292999E 00	2.290138E 00	2.861023E-03	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

C_1 = 2.16228E 00

C_2 = 3.83947E-19

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 4.583891E-03

d.f. = 5

t_α = 2.57

α = 0.05

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
0.0	2.16228E 00	2.63870E-03	2.14869E 00	2.17588E 00	2.15550E 00	2.16906E 00
4.000E-01	2.17764E 00	2.22502E-03	2.16455E 00	2.19074E 00	2.17192E 00	2.18336E 00
8.000E-01	2.19300E 00	1.90913E-03	2.18024E 00	2.20576E 00	2.18809E 00	2.19790E 00
1.200E 00	2.20836E 00	1.74496E-03	2.19575E 00	2.22096E 00	2.20387E 00	2.21284E 00
1.600E 00	2.22371E 00	1.77512E-03	2.21108E 00	2.23635E 00	2.21915E 00	2.22828E 00
2.000E 00	2.23907E 00	1.99079E-03	2.22623E 00	2.25192E 00	2.23396E 00	2.24419E 00
2.400E 00	2.25443E 00	2.34126E-03	2.24120E 00	2.26766E 00	2.24841E 00	2.26045E 00
2.300E 00	2.26979E 00	2.77534E-03	2.25602E 00	2.28356E 00	2.26265E 00	2.27692E 00
3.200E 00	2.28515E 00	3.26132E-03	2.27069E 00	2.29960E 00	2.27676E 00	2.29353E 00

Table G-39

ELECTRICAL RESISTIVITY OF A-286 STEEL: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	7.631000E 01	7.618828E 01	1.217194E-01	1
9.600000D 01	7.785999E 01	7.787509E 01	-1.510620E-02	2
1.190000D 02	7.975000E 01	7.988042E 01	-1.304169E-01	3
1.410000D 02	8.162999E 01	8.171527E 01	-8.528137E-02	4
1.715000D 02	8.407999E 01	8.412428E 01	-4.429626E-02	5
2.035000D 02	8.659999E 01	8.648349E 01	1.165009E-01	6
2.290000D 02	8.839000E 01	8.824008E 01	1.499176E-01	7
2.555000D 02	8.992999E 01	8.994963E 01	-1.963806E-02	8
2.820000D 02	9.142000E 01	9.154099E 01	-1.209869E-01	9
2.985000D 02	9.250000E 01	9.247212E 01	2.787781E-02	10

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 6.85437E 01

C_2 = 1.05280E-01

C_3 = -8.41470E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 1.153477E-01

d.f. = 7

t_α = 2.36

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	7.64276E 01	8.20595E-02	7.60935E 01	7.67616E 01	7.62339E 01	7.66212E 01
90.	7.73373E 01	6.90813E-02	7.70200E 01	7.76546E 01	7.71743E 01	7.75004E 01
100.	7.82302E 01	5.92356E-02	7.79242E 01	7.85363E 01	7.80904E 01	7.83700E 01
110.	7.91063E 01	5.28072E-02	7.88069E 01	7.94057E 01	7.89817E 01	7.92310E 01
120.	7.99656E 01	4.97298E-02	7.96691E 01	8.02620E 01	7.98482E 01	8.00829E 01
130.	8.08080E 01	4.94007E-02	8.05119E 01	8.11042E 01	8.06914E 01	8.09246E 01
140.	8.16336E 01	5.08484E-02	8.13361E 01	8.19311E 01	8.15136E 01	8.17536E 01
150.	8.24424E 01	5.31029E-02	8.21427E 01	8.27421E 01	8.23171E 01	8.25677E 01
160.	8.32343E 01	5.54221E-02	8.29323E 01	8.35363E 01	8.31035E 01	8.33651E 01
170.	8.40095E 01	5.73173E-02	8.37055E 01	8.43134E 01	8.38742E 01	8.41447E 01
180.	8.47678E 01	5.85010E-02	8.44625E 01	8.50730E 01	8.46297E 01	8.49058E 01
190.	8.55092E 01	5.88289E-02	8.52036E 01	8.58148E 01	8.53704E 01	8.56480E 01
200.	8.62338E 01	5.82684E-02	8.59288E 01	8.65388E 01	8.60963E 01	8.63714E 01
210.	8.69416E 01	5.68929E-02	8.66381E 01	8.72452E 01	8.68074E 01	8.70759E 01
220.	8.76326E 01	5.48936E-02	8.73311E 01	8.79341E 01	8.75031E 01	8.77622E 01
230.	8.83067E 01	5.26265E-02	8.80075E 01	8.86060E 01	8.81825E 01	8.84309E 01
240.	8.89641E 01	5.06562E-02	8.86667E 01	8.92614E 01	8.88445E 01	8.90836E 01
250.	8.96045E 01	4.98073E-02	8.93080E 01	8.99010E 01	8.94870E 01	8.97221E 01
260.	9.02282E 01	5.10715E-02	8.99305E 01	9.05259E 01	9.01077E 01	9.03487E 01
270.	9.08350E 01	5.53099E-02	9.05331E 01	9.11369E 01	9.07045E 01	9.09655E 01
280.	9.14250E 01	6.29380E-02	9.11149E 01	9.17351E 01	9.12765E 01	9.15735E 01
290.	9.19982E 01	7.38820E-02	9.16749E 01	9.23214E 01	9.18238E 01	9.21725E 01
300.	9.25545E 01	8.78199E-02	9.22124E 01	9.28966E 01	9.23472E 01	9.27617E 01

Table G-40

ELECTRICAL RESISTIVITY OF A-286 STEEL: POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	7.623000E 01	7.635333E 01	-1.233368E-01	1
9.900000D 01	7.828999E 01	7.826317E 01	2.682495E-02	2
1.115000D 02	7.939000E 01	7.934590E 01	4.409790E-02	3
1.455000D 02	8.225000E 01	8.220743F 01	4.257202E-02	4
1.755000D 02	8.467999E 01	8.463095F 01	4.904175E-02	5
1.990000D 02	8.645999E 01	8.646297E 01	-2.975464E-03	6
2.235000D 02	8.823000E 01	8.831088E 01	-8.088684F-02	7
2.620000D 02	9.109999E 01	9.108665E 01	1.333618E-02	8
2.750000D 02	9.207999E 01	9.198859E 01	9.140015E-02	9
2.990000D 02	9.367000E 01	9.360681E 01	6.318665E-02	10
3.300000D 02	9.567999E 01	9.560698E 01	7.301331E-02	11
3.705000D 02	9.809000E 01	9.806720F 01	2.279663E-02	12
4.215000D 02	1.002800E 02	1.009189E 02	-6.389008E-01	13
4.645000D 02	1.035300E 02	1.031098F 02	4.201508E-01	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 6.91052E 01

C_2 = 9.77321E-02

C_3 = -5.27987E-05

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.396476E-01

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	7.65859E 01	1.46749E-01	7.59675F 01	7.72040E 01	7.62630E 01	7.69087E 01
100.	7.83504E 01	1.19895F-01	7.77608E 01	7.89399E 01	7.80866E 01	7.86142E 01
120.	8.00727E 01	9.97437E-02	7.95016F 01	8.06438E 01	7.98533E 01	8.02921E 01
140.	8.17528E 01	8.69710F-02	8.11919E 01	8.23137E 01	8.15615E 01	8.19441E 01
160.	8.33907E 01	8.13484E-02	8.28339E 01	8.39474E 01	8.32117E 01	8.35696E 01
180.	8.49863E 01	8.12256E-02	8.44296E 01	8.55429E 01	8.48076E 01	8.51650E 01
200.	8.65396E 01	8.41576E-02	8.59809E 01	8.70984E 01	8.63545E 01	8.67248E 01
220.	8.80508E 01	8.79844E-02	8.74891F 01	8.86124E 01	8.78572E 01	8.82443E 01
240.	8.95197E 01	9.12876E-02	8.89555E 01	9.00838E 01	8.93188E 01	8.97205E 01
260.	9.09463E 01	9.33243E-02	9.03805E 01	9.15121E 01	9.07410E 01	9.11516E 01
280.	9.23307E 01	9.38613E-02	9.17645F 01	9.28969E 01	9.21242E 01	9.25372E 01
300.	9.36729E 01	9.30928E-02	9.31073E 01	9.42385E 01	9.34681E 01	9.38777E 01
320.	9.49729E 01	9.16535E-02	9.44084E 01	9.55373E 01	9.47712E 01	9.51745E 01
340.	9.62305E 01	9.06919E-02	9.56668E 01	9.67943E 01	9.60310E 01	9.64301E 01
360.	9.74460F 01	9.18859F-02	9.68813E 01	9.80106E 01	9.72439E 01	9.76481E 01
380.	9.86192E 01	9.72013F-02	9.80503E 01	9.91882E 01	9.84054E 01	9.88331E 01
400.	9.97502E 01	1.08281E-01	9.91717E 01	1.00329E 02	9.95120E 01	9.99884E 01
420.	1.00839E 02	1.75888F-01	1.00243E 02	1.01434E 02	1.00562E 02	1.01116E 02
440.	1.01885E 02	1.49941E-01	1.01264F 02	1.02507E 02	1.01556E 02	1.02215E 02
460.	1.02890E 02	1.79958F-01	1.02230E 02	1.03549E 02	1.02494E 02	1.03286E 02

Table G-41

ELECTRICAL RESISTIVITY OF A-286 STEEL: POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
4.645000D 02	7.642000E 01	7.642316E 01	-3.158569E-03	14
9.900000D 01	7.660999E 01	7.661424E 01	-4.257202E-03	2
1.115000D 02	7.659999E 01	7.660155E 01	-1.556396E-03	3
1.455000D 02	7.657999E 01	7.656926E 01	1.072693E-02	4
1.755000D 02	7.653999E 01	7.654343E 01	-3.433228E-03	5
1.990000D 02	7.653000E 01	7.652496E 01	5.035400E-03	6
2.235000D 02	7.650999E 01	7.650734E 01	2.655029E-03	7
2.620000D 02	7.646999E 01	7.648303E 01	-1.304626E-02	8
2.750000D 02	7.646999E 01	7.647574E 01	-5.752563E-03	9
2.990000D 02	7.646999E 01	7.646355E 01	6.439209E-03	10
3.300000D 02	7.645000E 01	7.645018E 01	-1.831055E-04	11
3.705000D 02	7.643999E 01	7.643675E 01	3.234863E-03	12
4.215000D 02	7.642999E 01	7.642632E 01	3.677368E-03	13

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

$C_1 = 7.67301E-01$

$C_2 = -1.30793E-03$

$C_3 = 1.39341E-06$

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

$s_e = 6.77172E-03$

d.f. = 10

$t_\alpha = 2.23$

$\alpha = 0.05$

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	7.66343E 01	5.33245E-03	7.66151E 01	7.66535E 01	7.66224E 01	7.66462E 01
100.	7.66132E 01	4.32518E-03	7.65953E 01	7.66311E 01	7.66035E 01	7.66228E 01
120.	7.65932E 01	3.50512E-03	7.65762E 01	7.66102E 01	7.65853E 01	7.66010E 01
140.	7.65742E 01	2.89895E-03	7.65578E 01	7.65907E 01	7.65678E 01	7.65807E 01
160.	7.65565E 01	2.52730E-03	7.65403E 01	7.65726E 01	7.65508E 01	7.65621E 01
180.	7.65398E 01	2.37799E-03	7.65238E 01	7.65558E 01	7.65345E 01	7.65451E 01
200.	7.65242E 01	2.39141E-03	7.65082E 01	7.65402E 01	7.65189E 01	7.65295E 01
220.	7.65098E 01	2.48686E-03	7.64937E 01	7.65258E 01	7.65042E 01	7.65153E 01
240.	7.64964E 01	2.59810E-03	7.64802E 01	7.65126E 01	7.64906E 01	7.65022E 01
260.	7.64842E 01	2.68461E-03	7.64679E 01	7.65004E 01	7.64782E 01	7.64902E 01
280.	7.64731E 01	2.72768E-03	7.64568E 01	7.64893E 01	7.64670E 01	7.64792E 01
300.	7.64631E 01	2.72526E-03	7.64468E 01	7.64794E 01	7.64570E 01	7.64692E 01
320.	7.64542E 01	2.69043E-03	7.64380E 01	7.64704E 01	7.64482E 01	7.64602E 01
340.	7.64464E 01	2.65297E-03	7.64302E 01	7.64626E 01	7.64405E 01	7.64523E 01
360.	7.64398E 01	2.66148E-03	7.64236E 01	7.64560E 01	7.64339E 01	7.64457E 01
380.	7.64342E 01	2.77927E-03	7.64179E 01	7.64506E 01	7.64280E 01	7.64404E 01
400.	7.64298E 01	3.06661E-03	7.64132E 01	7.64464E 01	7.64230E 01	7.64367E 01
420.	7.64265E 01	3.55798E-03	7.64095E 01	7.64436E 01	7.64186E 01	7.64344E 01
440.	7.64243E 01	4.25664E-03	7.64065E 01	7.64422E 01	7.64148E 01	7.64338E 01
460.	7.64232E 01	5.14841E-03	7.64043E 01	7.64422E 01	7.64118E 01	7.64347E 01

Table G-42

ELECTRICAL RESISTIVITY OF A-286 STEEL:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^{o}K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.15820	-0.55743	0.87383	0.23758	0.55398
100	0.12020	-0.54827	0.78867	-0.18206	0.42246
120	0.10710	-0.54045	0.75465	-0.14554	0.35974
140	0.11920	-0.52379	0.76219	-0.12153	0.35993
160	0.15640	-0.48936	0.80216	-0.09162	0.40442
180	0.21850	-0.43083	0.86783	-0.03867	0.47567
200	0.30580	-0.34440	0.95600	0.04642	0.56517
220	0.41820	-0.22964	1.06604	0.16479	0.67160
240	0.55560	-0.08904	1.20024	0.31050	0.80069
260	0.71810	0.07211	1.36408	0.46950	0.96669
280	0.90570	0.24564	1.56575	0.62252	1.18887
300	1.11840	0.42173	1.81506	0.75804	1.47875

Table G-43

ELECTRICAL RESISTIVITY OF A-286 DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3.74(14)	76.70	945.1	1.36(17)	77.20
11.0	1.58(15)	76.54	995.4	1.43(17)	77.19
15.7	2.26(15)	76.55	1049.7	1.51(17)	77.31
16.5	2.38(15)	76.57	1102.3	1.59(17)	77.24
26.1	3.76(15)	76.59	1166.2	1.68(17)	77.23
31.1	4.48(15)	76.59	1204.7	1.73(17)	77.25
34.9	5.03(15)	76.59	1214.3	1.75(17)	77.24
40.9	5.89(15)	76.59	1255.9	1.81(17)	77.31
59.0	8.50(15)	76.61	1307.1	1.88(17)	77.31
63.0	9.07(15)	76.30	1358.3	1.96(17)	77.32
71.8	1.03(16)	76.60	1409.5	2.03(17)	77.34
81.0	1.17(16)	76.33	1460.7	2.10(17)	77.33
82.1	1.18(16)[b]	76.33	1512.5	2.18(17)	77.33
90.1	1.30(16)	76.63	1563.1	2.25(17)	77.34
128.3	1.85(16)	76.61	1613.1	2.32(17)	77.28
164.8	2.37(16)	76.57	1662.7	2.39(17)	77.28
197.6	2.85(16)	76.57	1711.9	2.47(17)	77.25
234.8	3.38(16)	76.49	1756.7	2.53(17)	77.37
235.0	3.38(16)	76.39	1807.9	2.60(17)	77.32
237.8	3.42(16)	76.57	1859.2	2.68(17)	77.37
273.8	3.94(16)	76.60	1899.1	2.73(17)	77.35
309.7	4.46(16)	76.65	1902.4	2.74(17)[b]	76.55
317.2	4.57(16)	77.20	1902.4	2.74(17)[b]	76.57
373.3	5.38(16)	77.18	1902.4	2.74(17)[b]	76.56
431.5	6.21(16)	77.21	1902.4	2.74(17)[b]	76.64
491.5	7.08(16)	77.24	1902.4	2.74(17)[b]	76.56
593.6	8.55(16)	77.35	1902.4	2.74(17)[b]	76.55
610.2	8.79(16)	77.35	1902.4	2.74(17)[b]	76.54
639.2	9.20(16)[b]	76.40	1902.4	2.74(17)[b]	76.50
641.3	9.23(16)	76.68	1905.8	2.74(17)	76.82
666.5	9.60(16)	76.76	1925.4	2.77(17)	76.93
674.1	9.71(16)[b]	76.40	1960.3	2.82(17)	76.98
674.1	9.71(16)[b]	76.41	2000.3	2.88(17)	77.03
674.1	9.71(16)[b]	76.39	2046.1	2.95(17)	77.00
674.1	9.71(16)[b]	76.39	2080.3	3.00(17)	77.00
725.7	1.05(17)	77.12	2120.3	3.05(17)	76.99
777.4	1.12(17)	77.10	2158.6	3.11(17)	76.93
811.7	1.17(17)	77.12	2200.3	3.17(17)	76.95
867.8	1.25(17)	77.13	2237.1	3.22(17)	76.93
902.6	1.30(17)[b]	76.44	2305.0	3.32(17)	76.96
902.6	1.30(17)[b]	76.42	2309.8	3.33(17)	77.00
902.6	1.30(17)[b]	76.43			

[a] Neutron fluence for 1 > MeV
[b] Reactor at zero power

Table G-44

ELECTRICAL RESISTIVITY OF STAINLESS STEEL 347: PREIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	5.709999E 01	5.705925E 01	4.074097E-02	1
9.600000D 01	5.889000E 01	5.895422E 01	-6.422424E-02	2
1.185000D 02	6.115999E 01	6.121053E 01	-5.053711E-02	3
1.410000D 02	6.343999E 01	6.342741E 01	1.257324E-02	4
1.705000D 02	6.639999E 01	6.627425E 01	1.257477E-01	5
2.025000D 02	6.945000E 01	6.928569E 01	1.643066E-01	6
2.280000D 02	7.125000E 01	7.162833E 01	-3.783264E-01	7
2.540000D 02	7.410999E 01	7.396477E 01	1.452179E-01	8
2.805000D 02	7.625999E 01	7.629195E 01	-3.195190E-02	9
2.970000D 02	7.775000E 01	7.771330E 01	3.669739E-02	10

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 4.88843E 01

C_2 = 1.08634E-01

C_3 = -3.89444E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 1.764297E-01

d.f. = 7

t_α = 2.36

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	5.73257E 01	1.25544E-01	5.68147E 01	5.78368E 01	5.70294E 01	5.76220E 01
90.	5.83459E 01	1.05567E-01	5.78607E 01	5.88311E 01	5.80967E 01	5.85950E 01
100.	5.93582E 01	9.04462E-02	5.88903E 01	5.98261E 01	5.91448E 01	5.95717E 01
110.	6.03628E 01	8.06236E-02	5.99050E 01	6.08206E 01	6.01725E 01	6.05530E 01
120.	6.13596E 01	7.59832E-02	6.09062E 01	6.18129E 01	6.11802E 01	6.15389E 01
130.	6.23485E 01	7.55682E-02	6.18956E 01	6.28015E 01	6.21702E 01	6.25269E 01
140.	6.33297E 01	7.78564E-02	6.28746E 01	6.37848E 01	6.31460E 01	6.35134E 01
150.	6.43031E 01	8.13437E-02	6.38446E 01	6.47616E 01	6.41112E 01	6.44951E 01
160.	6.52687E 01	8.48894E-02	6.48067E 01	6.57308E 01	6.50684E 01	6.54691E 01
170.	6.62265E 01	8.77488E-02	6.57615E 01	6.66916E 01	6.60195E 01	6.64336E 01
180.	6.71766E 01	8.94865E-02	6.67097E 01	6.76434E 01	6.69654E 01	6.73878E 01
190.	6.81188E 01	8.98926E-02	6.76515E 01	6.85861E 01	6.79067E 01	6.83310E 01
200.	6.90533E 01	8.89245E-02	6.85870E 01	6.95195E 01	6.88434E 01	6.92631E 01
210.	6.99800E 01	8.67137E-02	6.95160E 01	7.04439E 01	6.97753E 01	7.01846E 01
220.	7.08988E 01	8.35811E-02	7.04381E 01	7.13596E 01	7.07016E 01	7.10961E 01
230.	7.18099E 01	8.01011E-02	7.13526E 01	7.22672E 01	7.16209E 01	7.19989E 01
240.	7.27132E 01	7.72129E-02	7.22587E 01	7.31677E 01	7.25310E 01	7.28954E 01
250.	7.36087E 01	7.62303E-02	7.31552E 01	7.40623E 01	7.34288E 01	7.37886E 01
260.	7.44965E 01	7.87120E-02	7.40405E 01	7.49524E 01	7.43107E 01	7.46822E 01
270.	7.53764E 01	8.59268E-02	7.49133E 01	7.58395E 01	7.51736E 01	7.55792E 01
280.	7.62485E 01	9.84173E-02	7.57718E 01	7.67253E 01	7.60163E 01	7.64808E 01
290.	7.71129E 01	1.15987E-01	7.66146E 01	7.76112E 01	7.68392E 01	7.73866E 01
300.	7.79695E 01	1.38105E-01	7.74407E 01	7.84982E 01	7.76435E 01	7.82954E 01

Table G-45

ELECTRICAL RESISTIVITY OF STAINLESS STEEL 347: POSTIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (^oK)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.7399990 01	5.748000E 01	5.738678F 01	9.321594E-02	1
9.7500000 01	5.940999E 01	5.946486F 01	-5.487061E-02	2
1.1000000 02	6.068999E 01	6.073718E 01	-4.719543E-02	3
1.4500000 02	6.417000E 01	6.421794E 01	-4.794312E-02	4
1.7500000 02	6.706999E 01	6.710559E 01	-3.559875E-02	5
1.9750000 02	6.925999E 01	6.921326F 01	4.673767E-02	6
2.2250000 02	7.150999E 01	7.149675E 01	1.324463E-02	7
2.6050000 02	7.493999E 01	7.484996E 01	9.002686E-02	8
2.7350000 02	7.598000F 01	7.596454E 01	1.545715E-02	9
2.9750000 02	7.798999E 01	7.797853E 01	1.145935E-02	10
3.2850000 02	8.043999E 01	8.049615F 01	-5.615760E-02	11
3.6850000 02	8.356000E 01	8.360509F 01	-4.508972E-02	12
4.1950000 02	8.732999E 01	8.734084E 01	-1.084900E-02	13
4.6250000 02	9.031999E 01	9.029190E 01	2.809143E-02	14

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 4.90137E 01

C_2 = 1.11985E-01

C_3 = -4.91557E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.594057E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (^oK)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	5.76578F 01	3.40001E-02	5.75138E 01	5.78018E 01	5.75830E 01	5.77326E 01
100.	5.97206E 01	2.77673F-02	5.95832E 01	5.98580E 01	5.96595E 01	5.97816E 01
120.	6.17440F 01	2.31174F-02	6.16108F 01	6.18771F 01	6.16931E 01	6.17948E 01
140.	6.37281E 01	2.02047F-02	6.35972E 01	6.38589E 01	6.36836F 01	6.37725E 01
160.	6.56728E 01	1.99610F-02	6.55429F 01	6.58028E 01	6.56311E 01	6.57145E 01
180.	6.75783F 01	1.99827E-02	6.74483F 01	6.77082E 01	6.75365E 01	6.76200E 01
200.	6.94444E 01	1.96916E-02	6.93139E 01	6.95748E 01	6.94010E 01	6.94877E 01
220.	7.12712F 01	2.05873E-02	7.11400F 01	7.14023E 01	7.12259E 01	7.13165E 01
240.	7.30586E 01	2.13455E-02	7.29269F 01	7.31903E 01	7.30117F 01	7.31056E 01
260.	7.48068F 01	2.17995E-02	7.46747E 01	7.49389E 01	7.47588E 01	7.48547E 01
280.	7.65156E 01	2.19014E-02	7.63834E 01	7.66477E 01	7.64674E 01	7.65638E 01
300.	7.81851E 01	2.17041F-02	7.80531E 01	7.83171E 01	7.81373E 01	7.82328E 01
320.	7.98152F 01	2.13657E-02	7.96835F 01	7.99470F 01	7.97682E 01	7.98622E 01
340.	8.14061E 01	2.11668E-02	8.12745E 01	8.15376F 01	8.13595E 01	8.14526E 01
360.	8.29576F 01	2.15119E-02	8.28257E 01	8.30894E 01	8.29103E 01	8.30049E 01
380.	8.44698E 01	2.28646E-02	8.43368F 01	8.46027E 01	8.44195E 01	8.45201E 01
400.	8.59427E 01	2.55968F-02	8.58073F 01	8.60780E 01	8.58863E 01	8.59990E 01
420.	8.73762F 01	2.98682E-02	8.72367F 01	8.75157E 01	8.73105E 01	8.74419E 01
440.	8.87704F 01	3.56455E-02	8.86245E 01	8.89163E 01	8.86920E 01	8.88488E 01
460.	9.01253E 01	4.28111E-02	8.99703F 01	9.02803E 01	9.00311E 01	9.02195E 01

Table G-46

ELECTRICAL RESISTIVITY OF STAINLESS STEEL 347: POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	5.748000E 01	5.747508E 01	4.913330E-03	1
9.750000D 01	5.739000E 01	5.745418E 01	-6.417847E-02	2
1.100000D 02	5.746999E 01	5.744139E 01	2.859497E-02	3
1.450000D 02	5.742999E 01	5.740648E 01	2.351379E-02	4
1.750000D 02	5.739999E 01	5.737758E 01	2.241516E-02	5
1.975000D 02	5.735999E 01	5.735654E 01	3.448486E-03	6
2.225000D 02	5.732999E 01	5.733379E 01	-3.799438E-03	7
2.605000D 02	5.731000E 01	5.730046E 01	9.536743E-03	8
2.735000D 02	5.729999E 01	5.728940E 01	1.058960E-02	9
2.975000D 02	5.726999E 01	5.726947E 01	5.187988E-04	10
3.285000D 02	5.721999E 01	5.724463E 01	-2.464294E-02	11
3.685000D 02	5.717999E 01	5.721407E 01	-3.407288E-02	12
4.195000D 02	5.717999E 01	5.717757E 01	2.426147E-03	13
4.625000D 02	5.717000E 01	5.714894E 01	2.105713E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2$$

C_1 = 5.75596E 01

C_2 = -1.13248E-03

C_3 = 5.28909E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 2.773777E-02

d.f. = 11

t_α = 2.20

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	5.74724E 01	1.68588E-02	5.74009E 01	5.75437E 01	5.74353E 01	5.75094E 01
100.	5.74516E 01	1.37682E-02	5.73835E 01	5.75197E 01	5.74213E 01	5.74819E 01
120.	5.74313E 01	1.14626E-02	5.73652E 01	5.74973E 01	5.74061E 01	5.74565E 01
140.	5.74114E 01	1.00184E-02	5.73465E 01	5.74763E 01	5.73893E 01	5.74334E 01
160.	5.73919E 01	9.40169E-03	5.73275E 01	5.74563E 01	5.73712E 01	5.74126E 01
180.	5.73729E 01	9.41246E-03	5.73084E 01	5.74373E 01	5.73521E 01	5.73936E 01
200.	5.73542E 01	9.76396E-03	5.72895E 01	5.74189E 01	5.73327E 01	5.73757E 01
220.	5.73360E 01	1.02081E-02	5.72710E 01	5.74010E 01	5.73136E 01	5.73585E 01
240.	5.73182E 01	1.05840E-02	5.72529E 01	5.73835E 01	5.72950E 01	5.73415E 01
260.	5.73009E 01	1.08091E-02	5.72354E 01	5.73664E 01	5.72771E 01	5.73247E 01
280.	5.72839E 01	1.08597E-02	5.72184E 01	5.73495E 01	5.72600E 01	5.73078E 01
300.	5.72674E 01	1.07618E-02	5.72020E 01	5.73329E 01	5.72437E 01	5.72911E 01
320.	5.72513E 01	1.05940E-02	5.71860E 01	5.73167E 01	5.72280E 01	5.72746E 01
340.	5.72357E 01	1.04954E-02	5.71704E 01	5.73009E 01	5.72126E 01	5.72587E 01
360.	5.72204E 01	1.06665E-02	5.71550E 01	5.72858E 01	5.71970E 01	5.72439E 01
380.	5.72056E 01	1.13372E-02	5.71397E 01	5.72715E 01	5.71807E 01	5.72305E 01
400.	5.71912E 01	1.26920E-02	5.71241E 01	5.72583E 01	5.71633E 01	5.72191E 01
420.	5.71772E 01	1.48100E-02	5.71080E 01	5.72464E 01	5.71446E 01	5.72098E 01
440.	5.71637E 01	1.76746E-02	5.70913E 01	5.72360E 01	5.71248E 01	5.72026E 01
460.	5.71505E 01	2.12276E-02	5.70737E 01	5.72274E 01	5.71038E 01	5.71972E 01

Table G-47

ELECTRICAL RESISTIVITY OF STAINLESS STEEL 347:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^{o}K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.33210	-0.08970	0.75390	0.09932	0.56487
100	0.36240	-0.03160	0.75640	0.18490	0.53989
120	0.38440	0.00258	0.76621	0.23593	0.53286
140	0.39840	0.01911	0.77768	0.25655	0.54024
160	0.40410	0.02308	0.78511	0.25770	0.55049
180	0.40170	0.01857	0.78482	0.24990	0.55349
200	0.39110	0.00753	0.77466	0.23818	0.54401
220	0.37240	-0.00970	0.75450	0.22318	0.52161
240	0.34540	-0.03486	0.72566	0.20097	0.48982
260	0.31030	-0.07107	0.69167	0.16295	0.45764
280	0.26710	-0.12338	0.65758	0.09758	0.43661
300	0.21560	-0.19787	0.62907	-0.00171	0.43291

Table G-48

ELECTRICAL RESISTIVITY OF SS-347 DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm^2)	Electrical Resistivity ($\mu\Omega$-cm)
2.6	3 74(14)	57.38	945.1	1.36(17)	57.77
11.0	1.58(15)	57.27	995.4	1.43(17)	57.80
15.7	2.26(15)	57.26	1049.7	1.51(17)	57.84
16.5	2.38(15)	57.28	1102.3	1.59(17)	57.77
26.1	3.76(15)	57.24	1166.2	1.68(17)	57.77
31.1	4.48(15)	57.30	1204.7	1.73(17)	57.94
34.9	5.03(15)	57.41	1214.3	1.75(17)	57.80
40.9	5.89(15)	59.29	1255.9	1.81(17)	57.84
59.0	8.50(15)	57.28	1307.1	1.88(17)	57.84
63.0	9.07(15)	57.13	1358.3	1.96(17)	57.80
71.8	1.03(16)	57.28	1409.5	2.03(17)	57.84
81.0	1.17(16)	57.22	1460.7	2 10(17)	57.87
82.1	1.18(16)[b]	57.28	1512.5	2.18(17)	57.87
90.1	1.30(16)	57.30	1563.1	2.25(17)	57.87
128.3	1.85(16)	57.29	1613.1	2.32(17)	57.84
164 8	2 37(16)	57.46	1662.7	2.39(17)	58.02
197.6	2.85(16)	57.26	1711.9	2.47(17)	57.93
234.8	3 38(16)	57.25	1756.7	2.53(17)	57.92
235.0	3.38(16)	57.22	1807.9	2.60(17)	57.92
237.8	3.42(16)	56.97	1859.2	2.68(17)	57.94
273.8	3.94(16)	57.27	1899.1	2.73(17)	57.92
309.7	4 46(16)	57.34	1902.4	2.74(17)[b]	57.42
317.2	4.57(16)	57.73	1902.4	2.74(17)[b]	57.41
373.3	5.38(16)	57.70	1902.4	2.74(17)[b]	57.40
431.5	6.21(16)	57.75	1902.4	2.74(17)[b]	57.41
491.5	7.08(16)	57.80	1902.4	2.74(17)[b]	57.41
593.6	8.55(16)	57.40	1902.4	2.74(17)[b]	57.42
610.2	8.79(16)	57.96	1902.4	2 74(17)[b]	57.42
639.2	9.20(16)[b]	57.30	1902.4	2.74(17)[b]	57.33
641.3	9.23(16)	57.47	1905.8	2.74(17)	57.33
666.5	9.60(16)	57.06	1925.4	2.77(17)	57.63
674.1	9.71(16)[b]	57.26	1960.3	2.82(17)	57.67
674.1	9.71(16)[b]	57.26	2000.3	2.88(17)	57.72
674.1	9.71(16)[b]	57.21	2046.1	2.95(17)	57.72
674.1	9.71(16)[b]	57.25	2080.3	3.00(17)	57.64
725.7	1.05(17)	57.70	2120.3	3.05(17)	57.69
777.4	1.12(17)	57.68	2158.6	3.11(17)	57.66
811.7	1.17(17)	57.71	2200.3	3.17(17)	57.60
867.8	1.25(17)	57.73	2237.1	3.22(17)	57.60
902.6	1.30(17)[b]	57.29	2305.0	3 32(17)	57.66
902.6	1.30(17)[b]	57.29	2309.8	3.33(17)	57.70
902.6	1.30(17)[b]	57.28			

[a] Neutron fluence for i > MeV
[b] Reactor at zero power

Table G-49

ELECTRICAL RESISTIVITY OF STAINLESS STEEL 347: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	5.709999E 01	5.718500E 01	-8.500671E-02	0
1.180000D-01	5.728000E 01	5.719495E 01	8.505249E-02	1
9.200000D-01	5.729999E 01	5.726257E 01	3.741455E-02	2
9.710000D-01	5.724500E 01	5.726698E 01	-2.188110E-02	3
1.299999D 00	5.728699E 01	5.729462E 01	-7.629395E-03	4
2.740000D 00	5.739400E 01	5.741605E 01	-2.204895E-02	5
3.330000D 00	5.748000E 01	5.746581E 01	1.419067E-02	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2\phi$

C_1 = 5.71850E 01

C_2 = 8.43273E-19

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 5.845413E-02

d.f. = 5

t_α = 2.57

α = 0.05

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	5.71850E 01	3.36489E-02	5.70117E 01	5.73583E 01	5.70985E 01	5.72715E 01
4.000E-01	5.72187E 01	2.83736E-02	5.70517E 01	5.73857E 01	5.71458E 01	5.72916E 01
8.000E-01	5.72525E 01	2.43454E-02	5.70897E 01	5.74152E 01	5.71899E 01	5.73150E 01
1.200E 00	5.72862E 01	2.22518E-02	5.71254E 01	5.74469E 01	5.72290E 01	5.73434E 01
1.600E 00	5.73199E 01	2.26364E-02	5.71588E 01	5.74810E 01	5.72617E 01	5.73781E 01
2.000E 00	5.73536E 01	2.53867E-02	5.71898E 01	5.75174E 01	5.72884E 01	5.74189E 01
2.400E 00	5.73874E 01	2.98560E-02	5.72187E 01	5.75561E 01	5.73106E 01	5.74641E 01
2.800E 00	5.74211E 01	3.53990E-02	5.72455E 01	5.75967E 01	5.73301E 01	5.75121E 01
3.200E 00	5.74548E 01	4.15886E-02	5.72705E 01	5.76392E 01	5.73479E 01	5.75617E 01

Table G-50

ELECTRICAL RESISTIVITY OF BERYLLIUM: PREIRRADIATION

Input Data		Calculated Data		Run No.
Temperature (°K)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
7.739999D 01	1.594000E 00	1.594453E 00	-4.529953E-04	1
9.600000D 01	1.658000E 00	1.652813E 00	5.187035E-03	2
1.190000D 02	1.787999E 00	1.793706E 00	-5.706787E-03	3
1.405000D 02	2.007999E 00	1.994135E 00	1.386452E-02	4
1.700000D 02	2.330000E 00	2.377211E 00	-4.721069E-02	5
2.020000D 02	2.993999E 00	2.934114E 00	5.988503E-02	6
2.270000D 02	3.445999E 00	3.471555E 00	-2.555561E-02	7

Least Squares Fit Coefficients

$\rho = C_1 + C_2T + C_3T^2$

C_1 = 1.88534E 00

C_2 = -9.31788E-03

C_3 = 7.18310E-05

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 4.098797E-02

d.f. = 4

t_α = 2.78

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
80.	1.59962E 00	3.18435E-02	1.45533E 00	1.74392E 00	1.51110E 00	1.68815E 00
90.	1.62856E 00	2.50215E-02	1.49506E 00	1.76206E 00	1.55900E 00	1.69812E 00
100.	1.67186E 00	2.11612E-02	1.54362E 00	1.80009E 00	1.61303E 00	1.73068E 00
110.	1.72952E 00	2.01637E-02	1.60254E 00	1.85651E 00	1.67347E 00	1.78558E 00
120.	1.80156E 00	2.10349E-02	1.67348E 00	1.92963E 00	1.74308E 00	1.86003E 00
130.	1.88795E 00	2.25445E-02	1.75791E 00	2.01800E 00	1.82528E 00	1.95063E 00
140.	1.98872E 00	2.38614E-02	1.85687E 00	2.12057E 00	1.92238E 00	2.05505E 00
150.	2.10385E 00	2.45748E-02	1.97099E 00	2.23671E 00	2.03553E 00	2.17217E 00
160.	2.23335E 00	2.45513E-02	2.10052E 00	2.36617E 00	2.16510E 00	2.30160E 00
170.	2.37721E 00	2.38626E-02	2.24536E 00	2.50906E 00	2.31087E 00	2.44355E 00
180.	2.53544E 00	2.28038E-02	2.40505E 00	2.66584E 00	2.47205E 00	2.59883E 00
190.	2.70804E 00	2.19872E-02	2.57873E 00	2.83734E 00	2.64691E 00	2.76916E 00
200.	2.89500E 00	2.23888E-02	2.76516E 00	3.02484E 00	2.83276E 00	2.95724E 00
210.	3.09633E 00	2.50545E-02	2.96278E 00	3.22988E 00	3.02668E 00	3.16598E 00
220.	3.31202E 00	3.04921E-02	3.17000E 00	3.45404E 00	3.22725E 00	3.39679E 00
230.	3.54208E 00	3.85618E-02	3.38563E 00	3.69853E 00	3.43488E 00	3.64928E 00

Table G-51

ELECTRICAL RESISTIVITY OF BERYLLIUM: POSTIRRADIATION

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.7399999D 01	1.900999E 00	1.904504E 00	-3.504753E-03	1
9.6500000D 01	1.926999E 00	1.917630E 00	9.368896E-03	2
1.0800000D 02	1.962000E 00	1.960954E 00	1.046181E-03	3
1.4450000D 02	2.249000E 00	2.261292E 00	-1.229191E-02	4
1.7400000D 02	2.677999E 00	2.667637E 00	1.036263E-02	5
1.9700000D 02	3.079000E 00	3.073561E 00	5.438805E-03	6
2.2150000D 02	3.561000E 00	3.581537E 00	-2.053738E-02	7
2.6000000D 02	4.533000E 00	4.513328E 00	1.967239E-02	8
2.7350000D 02	4.825999E 00	4.872539E 00	-4.653931E-02	9
2.9700000D 02	5.554000E 00	5.530502E 00	2.349758E-02	10
3.2800000D 02	6.466999E 00	6.448742E 00	1.825714E-02	11
3.6800000D 02	7.726000E 00	7.687243E 00	3.875732E-02	12
4.1900000D 02	9.214999E 00	9.288941E 00	-7.394218E-02	13
4.6250000D 02	1.064200E 01	1.061156E 01	3.044224E-02	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2 + C_4T^3$$

C_1 = 2.69586E 00

C_2 = -1.98348E-02

C_3 = 1.33066E-04

C_4 = -1.14971E-07

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 3.485062E-02

d.f. = 10

t_α = 2.23

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$s_{\bar{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.90184E 00	2.44595E-02	1.80689E 00	1.99678E 00	1.84729E 00	1.95638E 00
100.	1.92807E 00	1.73425E-02	1.84126E 00	2.01488E 00	1.88940E 00	1.96674E 00
120.	2.03316E 00	1.50050E-02	1.94855E 00	2.11778E 00	1.99970E 00	2.06663E 00
140.	2.21160E 00	1.54139E-02	2.12662E 00	2.29658E 00	2.17723E 00	2.24597E 00
160.	2.45784E 00	1.62358E-02	2.37212E 00	2.54359E 00	2.42165E 00	2.49406E 00
180.	2.76642E 00	1.64578E-02	2.68047E 00	2.85237E 00	2.72972E 00	2.80312E 00
200.	3.13177E 00	1.59498E-02	3.04630E 00	3.21723E 00	3.09620E 00	3.16733E 00
220.	3.54838E 00	1.49822E-02	3.46378E 00	3.63297E 00	3.51497E 00	3.58179E 00
240.	4.01074E 00	1.40269E-02	3.92696E 00	4.09451E 00	3.97946E 00	4.04202E 00
260.	4.51333E 00	1.36081E-02	4.42990E 00	4.59676E 00	4.48298E 00	4.54367E 00
280.	5.05063E 00	1.40441E-02	4.96684E 00	5.13442E 00	5.01931E 00	5.08195E 00
300.	5.61712E 00	1.52268E-02	5.53231E 00	5.70193E 00	5.58316E 00	5.65108E 00
320.	6.20728E 00	1.67180E-02	6.12109E 00	6.29348E 00	6.17000E 00	6.24457E 00
340.	6.81560E 00	1.80391E-02	6.72809E 00	6.90311E 00	6.77538E 00	6.85583E 00
360.	7.43655E 00	1.88239E-02	7.34822E 00	7.52488E 00	7.39457E 00	7.47853E 00
380.	8.06467E 00	1.89477E-02	7.97616E 00	8.15308E 00	8.02237E 00	8.10687E 00
400.	8.69430E 00	1.87160E-02	8.60609E 00	8.78252E 00	8.65257E 00	8.73604E 00
420.	9.32004E 00	1.92247E-02	9.23128E 00	9.40880E 00	9.27717E 00	9.36291E 00
440.	9.93636E 00	2.24700E-02	9.84389E 00	1.00288E 01	9.88625E 00	9.98647E 00
460.	1.05377E 01	3.01420E-02	1.04349E 01	1.06405E 01	1.04705E 01	1.06049E 01

Table G-52

ELECTRICAL RESISTIVITY OF BERYLLIUM: POSTIRRADIATION-ANNEAL DATA TAKEN AT LN_2 TEMPERATURE AFTER EACH TEMPERATURE STEP OF ANNEAL

Input Data: Temperature (°K)	Input Data: Resistivity (μohm-cm)	Calculated Data: Resistivity (μohm-cm)	Calculated Data: Residuals (input-calc)	Run No.
7.739999D 01	1.900999E 00	1.909632E 00	-8.632660E-03	1
9.650000D 01	1.863000E 00	1.846971E 00	1.602936E-02	2
1.080000D 02	1.811000E 00	1.813667E 00	-2.667427E-03	3
1.445000D 02	1.721000E 00	1.728067E 00	-7.067680E-03	4
1.740000D 02	1.684999E 00	1.678756E 00	6.243705E-03	5
1.970000D 02	1.643999E 00	1.650876E 00	-1.876831E-03	6
2.215000D 02	1.674000E 00	1.629896E 00	-5.895568E-03	7
2.600000D 02	1.606999E 00	1.611685E 00	-4.685402E-03	8
2.735000D 02	1.613000E 00	1.608693E 00	4.306793E-03	9
2.970000D 02	1.615000E 00	1.606612E 00	8.387566E-03	10
3.280000D 02	1.605000E 00	1.608068E 00	-3.067970E-03	11
3.680000D 02	1.613999E 00	1.612617E 00	1.382878E-03	12
4.190000D 02	1.608999E 00	1.613521E 00	-4.521370E-03	13
4.625000D 02	1.603000E 00	1.600910E 00	2.089500E-03	14

Least Squares Fit Coefficients

$$\rho = C_1 + C_2T + C_3T^2 + C_4T^3$$

C_1 = 2.27065E 00

C_2 = -5.89622E-03

C_3 = 1.71825E-05

C_4 = -1.63566E-08

Statistical Terms

$$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$$

s_e = 7.828094E-03

d.f. = 10

t_α = 2.23

α = 0.05

Temperature (°K)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals: Lower	95% Confidence Limits on Individuals: Upper	95% Confidence Limits on the Mean: Lower	95% Confidence Limits on the Mean: Upper
80.	1.90054E 00	5.49405E-03	1.87922E 00	1.92187E 00	1.88829E 00	1.91279E 00
100.	1.83649E 00	3.89545E-03	1.81699E 00	1.85599E 00	1.82781E 00	1.84518E 00
120.	1.78226E 00	3.37041E-03	1.76326E 00	1.80127E 00	1.77475E 00	1.78978E 00
140.	1.73707E 00	3.46225E-03	1.71798E 00	1.75616E 00	1.72935E 00	1.74479E 00
160.	1.70013E 00	3.64686E-03	1.68087E 00	1.71938E 00	1.69199E 00	1.70826E 00
180.	1.67065E 00	3.69672E-03	1.65135E 00	1.68996E 00	1.66241E 00	1.67889E 00
200.	1.64785E 00	3.58261E-03	1.62865E 00	1.66705E 00	1.63986E 00	1.65584E 00
220.	1.63095E 00	3.36528E-03	1.61195E 00	1.64995E 00	1.62344E 00	1.63845E 00
240.	1.61915E 00	3.15069E-03	1.60034E 00	1.63797E 00	1.61213E 00	1.62618E 00
260.	1.61169E 00	3.05663E-03	1.59295E 00	1.63043E 00	1.60487E 00	1.61850E 00
280.	1.60776E 00	3.15458E-03	1.58894E 00	1.62658E 00	1.60072E 00	1.61479E 00
300.	1.60658E 00	3.42023E-03	1.58753E 00	1.62563E 00	1.59895E 00	1.61421E 00
320.	1.60738E 00	3.75518E-03	1.58801E 00	1.62674E 00	1.59900E 00	1.61575E 00
340.	1.60935E 00	4.05191E-03	1.58970E 00	1.62901E 00	1.60032E 00	1.61839E 00
360.	1.61173E 00	4.22819E-03	1.59189E 00	1.63157E 00	1.60230E 00	1.62116E 00
380.	1.61372E 00	4.25600E-03	1.59385E 00	1.63359E 00	1.60423E 00	1.62321E 00
400.	1.61454E 00	4.20395E-03	1.59473E 00	1.63436E 00	1.60517E 00	1.62392E 00
420.	1.61341E 00	4.31823E-03	1.59347E 00	1.63334E 00	1.60378E 00	1.62304E 00
440.	1.60953E 00	5.04718E-03	1.58876E 00	1.63030E 00	1.59827E 00	1.62078E 00
460.	1.60217E 00	6.77045E-03	1.57904E 00	1.62520E 00	1.58702E 00	1.61722E 00

Table G-53

ELECTRICAL RESISTIVITY OF BERYLLIUM:
CHANGE FROM PREIRRADIATION TO POSTIRRADIATION

Temp (^{o}K)	$\Delta\rho$ (μohm-cm)	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
		Lower	Upper	Lower	Upper
80	0.30222	0.16368	0.44075	0.21978	0.38465
90	0.27619	0.14656	0.40581	0.20981	0.34256
100	0.25621	0.13136	0.38105	0.19975	0.31266
120	0.23160	0.10839	0.35480	0.17885	0.28434
140	0.22288	0.09753	0.34822	0.16531	0.28044
160	0.22451	0.09814	0.35087	0.16476	0.28425
180	0.23098	0.10568	0.35627	0.17352	0.28843
200	0.23677	0.11208	0.36145	0.18066	0.29287
220	0.23536	0.10507	0.36564	0.16771	0.30300
230	0.23211	0.09431	0.36990	0.15093	0.31328

Table G-54

ELECTRICAL RESISTIVITY OF BERYLLIUM DURING IRRADIATION

Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm²)	Electrical Resistivity (μΩ-cm)	Radiation Exposure (MW-h)	Neutron Fluence[a] (n/cm²)	Electrical Resistivity (μΩ-cm)
2.6	3.74(14)	1.601	945.1	1.36(17)	1.736
11.0	1.58(15)	1.590	995.4	1.43(17)	1.793
15.7	2.26(15)	1.601	1049.7	1.51(17)	1.743
16.5	2.38(15)	1.536	1102.3	1.59(17)	1.743
26.1	3.76(15)	1.609	1166.2	1.68(17)	1.750
31.1	4.48(15)	1.615	1204.7	1.73(17)	1.767
34.9	5.03(15)	1.600	1214.3	1.75(17)	1.772
40.9	5.89(15)	1.623	1255.9	1.81(17)	1.759
59.0	8.50(15)	1.609	1307.1	1.88(17)	1.784
63.0	9.07(15)	1.577	1358.3	1.96(17)	1.794
71.8	1.03(16)	1.604	1409.5	2.03(17)	1.797
81.0	1.17(16)[b]	1.603	1460.7	2.10(17)	1.802
82.1	1.18(16)[b]	1.592	1512.5	2.18(17)	1.819
90.1	1.30(16)	1.602	1563.1	2.25(17)	1.834
128.3	1.85(16)	1.605	1613.1	2.32(17)	1.816
164.8	2.37(16)	1.607	1662.7	2.39(17)	1.819
197.6	2.85(16)	1.618	1711.9	2.47(17)	1.858
234.8	3.38(16)	1.612	1756.7	2.53(17)	1.831
235.0	3.38(16)	1.623	1807.9	2.60(17)	1.896
237.8	3.42(16)	1.632	1859.2	2.68(17)	1.834
273.8	3.94(16)	1.628	1899.1	2.73(17)	1.869
309.7	4.46(16)	1.661	1902.4	2.74(17)[b]	1.860
317.2	4.57(16)	1.663	1902.4	2.74(17)[b]	2.007
373.3	5.38(16)	1.652	1902.4	2.74(17)[b]	1.960
431.5	6.21(16)	1.666	1902.4	2.74(17)[b]	1.865
491.5	7.08(16)	1.672	1902.4	2.74(17)[b]	1.851
593.6	8.55(16)	1.676	1902.4	2.74(17)[b]	1.853
610.2	8.79(16)	1.683	1902.4	2.74(17)[b]	1.865
639.2	9.20(16)[b]	1.673	1902.4	2.74(17)[b]	2.071
641.3	9.23(16)	1.694	1905.8	2.74(17)	1.866
666.5	9.60(16)	1.697	1925.4	2.77(17)	1.863
674.1	9.71(16)[b]	1.697	1960.3	2.82(17)	1.855
674.1	9.71(16)[b]	1.688	2000.3	2.88(17)	1.873
674.1	9.71(16)[b]	1.693	2046.1	2.95(17)	1.876
674.1	9.71(16)[b]	1.686	2080.3	3.00(17)	1.870
725.7	1.05(17)	1.706	2120.3	3.05(17)	1.900
777.4	1.12(17)	1.704	2158.6	3.11(17)	1.891
811.7	1.17(17)	1.726	2200.3	3.17(17)	1.902
867.8	1.25(17)	1.717	2237.1	3.22(17)	1.900
902.6	1.30(17)[b]	1.723	2305.0	3.32(17)	1.908
902.6	1.30(17)[b]	1.720	2309.8	3.33(17)	1.918
902.6	1.30(17)[b]	1.726			

[a] Neutron fluence for 1 > MeV

[b] Reactor at zero power

Table G-55

ELECTRICAL RESISTIVITY OF BERYLLIUM: DATA TAKEN AT ZERO REACTOR POWER AS A FUNCTION OF RADIATION EXPOSURE

Input Data		Calculated Data		Run No.
Fluence (10^{17} n/cm^2)	Resistivity (μohm-cm)	Resistivity (μohm-cm)	Residuals (input-calc)	
0.0	1.594000E 00	1.588100E 00	5.899429E-03	0
1.1800000D-01	1.591999E 00	1.600283F 00	-8.283615E-03	1
9.2000000D-01	1.672999F 00	1.683081E 00	-1.008129F-02	2
9.7100000D-01	1.691000E 00	1.688346E 00	2.654076E-03	3
1.2999990 00	1.723000E 00	1.722312F 00	6.875992E-04	4
2.7400000 00	1.910999E 00	1.870978E 00	4.002094E-02	5
3.3300000 00	1.900999E 00	1.931890E 00	-3.089046E-02	6

Least Squares Fit Coefficients

$\rho = C_1 + C_2\Phi$

C_1 = 1.58810E 00

C_2 = 1.03240E-18

Statistical Terms

$s_e = \sqrt{\sum(\text{Residuals})^2/\text{d.f.}}$

s_e = 2.353069E-02

d.f. = 5

t_α = 2.57

α = 0.05

Fluence (10^{17} n/cm^2)	ρ (μohm-cm)	$S_{\overline{\rho}}$	95% Confidence Limits on Individuals		95% Confidence Limits on the Mean	
			Lower	Upper	Lower	Upper
0.0	1.58810F 00	1.35453F-02	1.51832F 00	1.65788F 00	1.55329E 00	1.62291E 00
4.000F-01	1.62940E 00	1.14218E-02	1.56217E 00	1.69662E 00	1.60004E 00	1.65875F 00
8.000E-01	1.67069F 00	9.80021E-03	1.60518E 00	1.73620E 00	1.64551E 00	1.69588E 00
1.200F 00	1.71199E 00	8.95747E-03	1.64728F 00	1.77670F 00	1.68897E 00	1.73501E 00
1.600F 00	1.75328E 00	9.11228F-03	1.68843E 00	1.81813E 00	1.72987E 00	1.77670F 00
2.000E 00	1.79458E 00	1.02194F-02	1.72865E 00	1.86051E 00	1.76832E 00	1.82084E 00
2.400E 00	1.83588F 00	1.20185F-02	1.76797F 00	1.90378E 00	1.80499E 00	1.86676E 00
2.800F 00	1.87717E 00	1.42499E-02	1.80647E 00	1.94787E 00	1.84055E 00	1.91379E 00
3.200E 00	1.91847E 00	1.67415F-02	1.84425E 00	1.99269F 00	1.87544E 00	1.96149E 00

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